GROUNDWATER MANAGEMENT PLAN

KINGS COUNTY WATER DISTRICT

ADOPTED:
JANUARY 1993

DATE OF FIRST REVISION:
DECEMBER 2001

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PREPARED BY:

TABLE OF CONTENTS

Figures

Tables

Appendices

List of Abbreviations

AB	Assembly Bill
ACWA	Association of California Water Agencies
AF	Acre-feet
bgs	below ground surface
CGPS	Continuously operating global positioning system
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DBCP	dibromochloropropane
DWR	Department of Water Resources
EPA	Environmental Protection Agency
ET	evapotranspiration
FKC	Friant-Kern Canal
FWA	Friant Water Authority
FWUA	Friant Water Users Authority
GAC	Groundwater Advisory Committee
GMP	Groundwater Management Plan
GPM	gallons per minute
GPS	Global Positioning System
ID	Irrigation District
IRWMP	Integrated Regional Water Management Plan
KCWD	Kings County Water District
KDWCD	Kaweah Delta Water Conservation District
KRAPO	Kings River Area Property Owners
KRCD	Kings River Conservation District
KRWA	Kings River Water Association
LIWD	Lakeside Irrigation Water District
MOU	Memorandum of Understanding
ND	Not detected
NRCS	Natural Resources Conservation Service
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WHPA	Wellhead protection area
WRI	Water Resources Investigation of the Kaweah Delta Water Conservation District

1 – INTRODUCTION

This Groundwater Management Plan (GMP or Plan) is an update of a Plan that was adopted by the Kings County Water District (KCWD or District) in January 1993 and updated in December 2001. The original Plan was prepared in accordance with the requirements prescribed in Assembly Bill No. 3030 (California Water Code Sections 10750 et seq.).

This GMP is a revision that satisfies the new requirements for GMPs created by the September 2002 California State Senate Bill No. 1938, which amended Sections 10753 and 10795 of the California Water Code. This Plan also addresses recommended components for a Groundwater Management Plan described in Appendix C of Department of Water Resources Bulletin 118 (2003 Update). Table 1.1 in Section 1.4 shows the required and recommended components for GMPs.

The primary motives for updating this GMP include:

1. Satisfy new State requirements for GMPs.
2. Maintain the District's eligibility for certain State grants, loans and special drought assistance that require an updated GMP.
3. Update and document the District's goals and objectives for groundwater management.
4. Update local groundwater information so the GMP is a useful reference document.
5. Continue the District's authority to manage local groundwater and help prevent the State from controlling groundwater resources.

This plan outlines the framework for KCWD's groundwater management efforts. General categories that are addressed include a description of the District's geology and hydrogeology, basin management objectives, stakeholder involvement, groundwater monitoring, groundwater resources protection, groundwater sustainability, groundwater operations, and groundwater planning and management. Within these categories, specific groundwater management elements are described including existing activities and planned actions to improve groundwater management. This GMP covers the entire area within the boundary of Kings County Water District, including areas where the District overlaps with other water management agencies.

1.1 - Background Information on Kings County Water District

Below is a brief description of the origin, physiography, geology, water supplies and facilities of the District. This GMP covers the area within the District boundaries, but the physiography, geology, hydrogeology and groundwater issues in neighboring lands are also discussed as they relate to groundwater conditions in the District.

History

Kings County Water District was formed in 1954 under the County Water District Act (Water Code sections 30000-33901) to provide a legal entity for water management in the northeast portion of Kings County (Figure 1). When the area's mutual water companies were originally formed, the corporate stock was held in private ownership and the water was distributed to shareholders on an acreage basis. However, the stock is transferable to anyone, and some of it was sold to parties outside of the District who began exporting the water. The recognition of this situation was a major reason for the formation of the Kings County Water District. The District has attempted to purchase as much Ditch company stock as feasible to ensure that as much surface water as possible is kept in the local area. This effort has lead to District ownership of the Riverside Ditch Company, but has met with varied success with Peoples Ditch Company (16% District owned), Last Chance Water Ditch Company (35% District owned), and Lakeside Ditch Company (7% District owned). The District continues to purchase canal company stock whenever it is available for sale.

Geography

KCWD is located in northeastern Kings County in the central part of the San Joaquin Valley, about 20 miles south of the City of Fresno. The District encompasses a land area of approximately 143,000 acres (223 square miles). Adjacent agricultural water agencies include Salyer Water District, Tulare Irrigation District, Laguna Irrigation District, Melga Water District, Consolidated Irrigation District and Alta Irrigation District. The District includes portions of the service areas of three major mutual ditch companies: Peoples Ditch Company and Last Chance Water Ditch Company, which possess water rights on the Kings River, and the Lakeside Ditch Company, which holds water rights on the Kaweah River. The District boundary completely encompasses the area (31,845 acres) of the Lakeside Irrigation Water District, which was formed to administer the water rights and distribution system of the Lakeside Ditch Company within the Lakeside Irrigation Water District. The District also overlaps the Consolidated and Alta Irrigation Districts, Kings River Conservation District and the Kaweah Delta Water Conservation District (Figure 2). Parts of the City of Hanford are also in the KCWD, but they do not receive water from KCWD. Refer to Figure 3 for a map of neighboring municipal water providers, Figure 4 for a map of neighboring ditch and mutual water companies, and Figure 5 for distribution facilities within District boundaries.

Topography

Land in the District generally slopes downward from the northeast to southwest at three to four feet per mile, with local variations caused by remnants of slough channels. Elevations range from 300 feet above sea level in the northeast to 200 feet above sea level in the southwest.

Climate

The climate of the District is characterized by cool, mild winters and hot, dry summers. Temperatures in the summer often exceed 100 degrees Fahrenheit. Fog is

experienced for long periods in the winter, with temperatures typically in the mid-30's. Winter temperatures occasionally drop into the 20's. The frost-free growing season averages around 250 days per year. Average annual precipitation is about 8.5 inches, with 80 percent of the rainfall occurring in the winter months. Annual crop use per acre averages many times the amount of average precipitation. As a result, agricultural crops grown within the District are heavily dependent upon irrigation from surface water deliveries and groundwater pumping, with water needs only partially satisfied by rainfall.

Soils and Agronomy

Refer to Figure 6 for a Natural Resources Conservation Service (NRCS) soils map of KCWD. Soils in the district are primarily loam (from clay loam to sandy loam) and loam mixtures. Most of the District has been fully developed for irrigated agriculture. A cropping map (land use map) is included as Figure 7. Major crops include corn, pasture, cotton, walnuts, peaches and nectarines.

Geology

KCWD is located in the Tulare Lake, Kaweah and Kings Groundwater Subbasins (Figure 7). The generalized stratigraphy includes, from oldest to youngest: basement complex, unconsolidated deposits and topsoil. Recent standing groundwater levels in the unconfined aquifer average about 125 to 140 feet below ground surface (bgs). Refer to Section 2 for more details on the geology in KCWD.

Water Demands

According to the KCWD 2001 GMP, the annual water demand for crops grown within the District is estimated to range from 1.3 AF/acre for grain to 5 AF/acre for irrigated pasture, with an average annual use in the District from 2.8 to 3.1 AF/acre, depending on crop patterns and double cropping. This may have increased due to a higher prevalence of double and triple cropping as a result of more dairy development in recent years.

Groundwater Supply

The groundwater beneath the Kings County Water District (which is extremely good quality for irrigation) is the only firm water supply available within the District. Agriculture, municipalities, and industry all regularly draw upon this valuable resource from individual wells, as surface water supplies are available only on an intermittent basis.

Conjunctive use of surface water and groundwater has been practiced within the District since its formation in 1954. Through the purchase of slough channels and other appropriate sites for use as recharge basins, and by the purchase and importation of available surplus water and flood water, the Kings County Water District has attempted to reduce the decline of groundwater levels within the District.

The Kings County Water District has, since 1964, engaged in a cooperative program with the State Department of Water Resources and USBR for the monitoring and

sampling of groundwater in the District. Water level measurements are annually obtained from between 230 to 280 wells in both the spring and fall. The data obtained in the spring (normally the last of January) reflects the "seasonal high" water table, as the measurements are made prior to pumping for pre-irrigation. The fall measurements (normally obtained in the first part of October) are taken after a full season of crop irrigation pumping.

Depth to the unconfined groundwater table within the District in spring 2010 ranged from about 50 feet near the Kings River in the north to about 275 feet in the southeastern portion of the District, with an average groundwater depth of about 125 feet. A current estimate of usable storage capacity in the unconfined aquifer is about 9 million AF.

Groundwater quality in the District is generally excellent for irrigation. The City of Hanford has problems with high levels of arsenic, sulfur and iron in its water supply.

Surface Water Supplies

The surface water supply of the District comes from various sources. A major portion is obtained from the Kings River through ownership of stock in the Peoples Ditch Company and the Last Chance Water Ditch Company, and from the Kaweah River through ownership of shares of Lakeside Ditch Company stock. The Kings County Water District has, since its formation, attempted to purchase all available water stock of these ditch companies to assist in preserving the water rights of the area. KCWD sells the Ditch Company water annually to growers.

In addition to the surface water distributed in the District from ditch companies, the District has purchased surplus surface water from the Central Valley Project (CVP) made available through short term contracts with the U.S. Bureau of Reclamation. The last short term contract expired in October 1983; however, temporary contracts have been executed annually thereafter in years that CVP water has been available. The temporary CVP contracts have resulted in the delivery of San Joaquin River water into the basin.

The District has also endeavored to divert and recharge as much flood water as possible from the San Joaquin, Kings, and Kaweah Rivers. All of the imported supplies have either recharged the underground from sinking basins or been diverted for direct surface irrigation within the District. Kings River water is usually taken in high flows for short durations. The substitution of imported surface water supplies in place of groundwater extractions is the key element in the District's conjunctive use program.

Kings River water is of excellent quality for irrigation. Salt content, measured as total dissolved solids (TDS), typically runs around 50 parts per million (ppm) and boron content is generally less than 0.1 ppm. Infiltration problems sometimes occur due to the purity of the water.

Facilities

The District owns and operates numerous intentional recharge basins located throughout the District. In addition, the District owns and operates the 10 mile Riverside Ditch for direct delivery of surface water for agricultural production. The District also includes an improvement district which was formed under the auspices of the Kings County Water District for the maintenance and operation of the Riverside Ditch.

The Apex Ranch Conjunctive Use Project was completed in 2001 and uses 50-acres of dry Kings River channel as a recharge area. The project was started after a survey of farmers indicated that most would prefer a source of summer water provided through a groundwater bank over winter water deliveries. Water for the project is diverted from the Kings River at People's Weir into Peoples Ditch and then into recharge areas. Water is then recovered with five recovery wells and conveyed to Riverside Ditch and other channels for delivery to KCWD growers during the irrigation season. The project has successfully diverted floodwater and winter release waters of the Kings River into the channel for recharge. Downstream of the project, in additional sections of the Old River, there are a series of earthen dams that are also used to backup water for groundwater recharge during certain "high flow" periods on the Kings River. A committee composed of local landowners was formed to monitor operations (groundwater levels, groundwater quality, etc.) at the project. Between 2002 and 2010, KCWD delivered 52,200 AF to the project. Also, during this period, 23,900 AF of flood water was diverted to the Old River during high flows. Total available groundwater storage potential in the project vicinity has been estimated to be 20,000 AF. It should be noted that from 2002 to 2010 10% of the water recharged in apex was left to contribute to the local aquifer, except for 2010 when approximately 31% was left and to date over 8,500 AF has been contributed to the local aquifer that would not be present but for the apex project.

Numerous other conveyance and recharge facilities are located in KCWD. These facilities are owned and operated by other water agencies including the canal delivery systems for Last Chance Water Ditch Company, Peoples Ditch Company, Lakeside Irrigation Water District, Kaweah-Delta Water Conservation District, Consolidated and Alta Irrigation Districts, and several private ditches used to convey water through the District. The facilities owned by the District and local canal companies are shown on Figure 5.

1.2 - Goals and Objectives of Groundwater Management Plan

This GMP documents the existing groundwater management efforts in KCWD and planned efforts to improve groundwater management. The purpose of the GMP is to help KCWD meet the following objectives:

1. Stabilize groundwater levels in order to minimize pumping costs and energy use, and provide groundwater reserves for use in droughts.
2. Maximize the use of surface water, including available flood water, for beneficial use, and thus reduce stress on groundwater resources.

3. Prevent groundwater degradation by protecting groundwater quality, importing clean surface water, and preventing intrusion of poor quality groundwater from neighboring areas.
4. Preserve, and, where feasible, enhance the existing quality of the area's groundwater.
5. Address potential changes in local hydrology brought about by surface water losses in the region (i.e. San Joaquin River Restoration), urban development, and drought.
6. Prevent surface water or groundwater exports that would reduce the long-term reliability of groundwater.
7. Coordinate groundwater management efforts between regional water users.
8. Maintain local management of the groundwater resources.
9. Implement a groundwater-monitoring program to provide an "early warning" system to future problems.
10. Develop groundwater storage facilities to reduce stress on local groundwater reserves during droughts.
11. Increase knowledge of the local geology and hydrogeology to better understand threats to groundwater quality and quantity.
12. Minimize possible "land subsidence" caused by groundwater pumping through in-lieu groundwater recharge, and wise and conservative use of pumped groundwater.

In addition, the District will take a proactive role in the legislative process. KCWD will participate in development of sound legislation concerning groundwater management if it becomes necessary. KCWD will also take an active role in opposing any legislation that is detrimental to local groundwater management efforts, or prevents the local management of groundwater.

1.3 - Statutory Authority for Groundwater Management

The State legislature enacted AB 255, (Costa), regarding Groundwater Management Programs, during the 1991 session. The Act was codified as Part 2.75, commencing with Section 10750 of Division 6 of the Water Code and became effective January 1, 1992.

The Act applies to local agencies whose jurisdiction includes groundwater basins subject to "a critical condition of groundwater overdraft" and covers the Kings Basin, Kaweah Basin and Tulare Lake Basin, which covers all of KCWD (Figure 8).

The Act provides that any district or other political subdivision of the State which is authorized to provide water service, and is exercising that authority, may by ordinance or resolution adopt a program for the management of groundwater resources within the area.

The Act also authorizes a district to exercise specified powers of a water replenishment district subject to approval of the voters of the district. The State legislature later passed similar legislation permitting districts in areas not subject to critical conditions of overdraft

to practice groundwater management activities. This legislation known as AB 3030 went into effect on January 1, 1993.

The authorities in AB255 and AB3030 remained unchanged with the amendments to the law provided by 2002 California Senate Bill 1938 (SB 1938), which also identified new requirements for GMPs. This GMP represents an updated version, and includes the additional components listed in California SB 1938.

The powers granted to an agency adopting a Groundwater Management Plan include:

1. The District may take any actions needed to replenish the groundwater within the District, including buying and selling water, delivering water in-lieu of groundwater pumping, and spreading water for recharge.

2. The District may take actions needed to protect or prevent interference with water, water quality, or water rights within the District.

3. Using water quality goals, the District may take any action needed to preserve the water within the District for beneficial uses. These actions include preventing contaminants from entering District groundwater supplies, removing contaminants, locating and characterizing contaminants within the District, identifying parties responsible for contamination of groundwater, and performing studies relative to the listed water quality goals.

4. The District may enter into agreements with other local agencies or private parties to manage mutual groundwater supplies, including those existing in overlapping areas.

5. The District may levy and collect general groundwater replenishment assessments, as well as water extraction fees based on the amount of groundwater extracted from the aquifer. However, these fees must be "ratified" by a majority vote in an election, according to the election rules applicable to the District.

6. The District may sue to recover the amount of District expenditures for protection of groundwater quality protection from parties responsible for the contamination.

7. The District is granted additional powers of a Replenishment District, which allows it to:
   a) Acquire and operate facilities, waters and rights needed to replenish the groundwater supplies;
   b) Store water in groundwater basins, acquire water rights, import water into the District, and conserve water;
   c) Participate in legal proceedings as required to defend water rights, and water supplies, and to prevent unlawful exportation of water from the District;

d) Under certain conditions, to exercise the right of eminent domain;
e) Act jointly with other entities in order to economically perform required activities;
f) Carry out investigations required to implement programs;
g) Fix rates for water for replenishment purposes;
h) To recapture and reclaim water as provided for in Water Code section 60221; and
i) Fix the terms and conditions of contracts for use of surface water in-lieu of groundwater

The powers granted under AB 3030, SB 1938 and under the Water Replenishment District Act (Water Code sections 60220 et seq.) either overlap or are in addition to the powers of the District under the County Water District Act. Included in Appendix A are copies of groundwater legislation, including AB 255 and AB 3030.

The District's overall strategy in using these powers is to limit its control over private groundwater facilities, and, through a combination of grower education, water conservation efforts, groundwater recharge, and groundwater banking, to reduce the rate of groundwater level decline, and, if possible, stabilize groundwater levels to help ensure that groundwater resources are sustainable.

1.4 - Groundwater Management Plan Components

This GMP includes the required and voluntary components for a GMP as identified in California Water Code Section 10753, et. seq. This Plan is also consistent with the recommended elements for a GMP as identified in DWR Bulletin 118 (2003), Appendix C. Table 1.1 identifies the appropriate section of the GMP where each component is addressed.

Table 1.1 - Location of Groundwater Management Plan Components

	Description	Plan Section(s)
	California Water Code Mandatory Requirements (10750 et seq.)	
1.	Documentation of public involvement	1.5, Appendix A
2.	Groundwater basin management objectives	1.2, 3
3.	Monitoring and management of groundwater elevations, groundwater quality, land subsidence, and surface water	5
4.	Plan to involve other agencies located in the groundwater basin	4.3
5.	Monitoring protocols	5.3
6.	Map of groundwater basin and agencies overlying the basin	Figures 1, 2, 3 4 & 7
	California Water Code Voluntary Components (10750 et seq.)	
7.	Control of saline water intrusion	6.3
8.	Identification and management of wellhead protection areas and recharge areas	6.2, 7.2
9.	Regulation of the migration of contaminated groundwater	6.3, 6.4
10.	Administration of well abandonment and well destruction program	6.1
11.	Mitigation of overdraft conditions	7.1, 7.2
12.	Replenishment of groundwater extracted by water users	7.2
13.	Monitoring of groundwater levels and storage	5.1, 9.3
14.	Facilitating conjunctive use operations	7.3
15.	Identification of well construction policies	8.1
16.	Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	6.4, 7, 8.2
17.	Development of relationships with state and federal regulatory agencies	4.2, 4.3
18.	Review of land use plans and coordination with land use planning agencies	9.1
	Additional Components Recommended by DWR (App. C of Bulletin 118)	
19.	Advisory committee of stakeholders	4.1
20.	Description of the area to be managed under the Plan	1.1, 2
21.	Descriptions of actions to meet management objectives and how they will improve water reliability	4 - 9
22.	Periodic groundwater reports	9.3
23.	Periodic re-evaluation of Groundwater Management Plan	9.5

1.5 - Adoption of Plan

Refer to Appendix B for documentation on the adoption of the GMP and the public process that was followed.

Groundwater Advisory Committee

A Groundwater Advisory Committee (GAC) was formed to assist with updating the GMP. The GAC included the District Manager, District consulting engineer and KCWD Board of Directors. The KCWD Board of Directors is comprised of local farmers and represents the local community. They are familiar with the local and regional water issues and are best suited to serve as the primary voice on the GAC.

Plan adoption

The original KCWD GMP was adopted through a formal public noticing process in 1993. Two duly noticed public meeting were held with relevant materials made available to the public. Copies of the draft GMP were also circulated to stakeholders for comments. No adverse comments on the GMP were received. A copy of the resolution adopting the GMP in 1993 is provided in Appendix B. A Board resolution adopting an update in 2001 is also included in Appendix B.

According to the water code, a GMP update requires a resolution from the governing body, however, for this update, the District also engaged the public by making the draft GMP available for public review and soliciting comments from local agencies, as described below. A copy of the KCWD resolution approving this updated GMP is also found in Appendix B.

A draft copy of the GMP will be sent to 10 neighboring and overlapping public agencies including Alta Irrigation District, Consolidated Irrigation District, Lakeside Irrigation District, Corcoran Irrigation District, City of Hanford, Armona Community Service District, Laguna Irrigation District, Tulare Irrigation District, Kings River Conservation District, and Kaweah Delta Water Conservation District. It is planned that at the KCWD Board meeting on March 3, 2011, this draft will be conditionally accepted and direct staff to make it available for public review at the District office and on the KRCD website. Comments from the public and neighboring agencies will be reviewed and addressed in this GMP.

1.6 - Kaweah Delta Water Conservation District Groundwater Management Plan

The Kaweah Delta Water Conservation District (KDWCD) is a regional water management agency covering 340,000 acres in Tulare and Kings County. The District includes 14 member water agencies and companies. Refer to Section 4.2 for more information on KDWCD and Figure 2 for a map showing the border of KDWCD in relation to KCWD. Note that only the eastern portion of KCWD is within the KDWCD border.

The Kaweah Delta Water Conservation District (KDWCD) was formed in 1927 under provisions of the Water Conservation District Act of 1927 for the purpose of conserving and storing waters of the Kaweah River and for conserving and protecting the underground waters of the Kaweah Delta. The District includes lands in both Tulare County and Kings County. The total area of the District is approximately 340,000 acres.

KCWD is a cooperating agency in the KDWCD GMP, which was updated in November 2006. KDWCD's original GMP was prepared in 1995 in accordance with the requirements prescribed in Assembly Bill No. 3030. The 2006 Plan was revised to satisfy the new requirements for GMPs created by the September 2002 Senate Bill No. 1938.

The KDWCD GMP officially recognizes stakeholders through the execution of a Memorandum of Understanding (MOU). The purpose of the MOU is to document the interests and responsibilities of participants. The MOU also promotes the sharing of information, the development of a course of action, and the resolving of differences that may arise regarding the GMP. Since the GMP's inception in 1995, thirteen stakeholders (including KCWD) have signed the MOU. A list of the stakeholders is provided in Section 4.2 – Relationships with Other Agencies.

The benefits of a regional plan were described in the GMP as follows:

> "The availability of groundwater to serve community and agricultural needs can be impacted by activities that take place a considerable distance beyond local boundaries. There is considerable common use of the groundwater resource and this coordinated Plan has been and will continue being a benefit to competing interests using the groundwater resource" (pg 1-2)

The two groundwater management plans share common goals and themes. This GMP focuses on groundwater issues unique to KCWD and its surrounding area, while the KDWCD GMP focuses on regional groundwater issues. KCWD considers both GMPs important resources in its groundwater management program.

2 - GEOLOGY AND HYDROGEOLOGY

This section discusses the geology and hydrogeology of Kings County Water District and immediate surrounding areas. The purpose of this section is to provide general background information on the local hydrogeology that will aid in selecting and implementing groundwater management programs. Most of the information on the District's geology was derived from Croft and Gordon (1968), Croft (1972), and Page (1986). Additional information was obtained from several KCWD reports documenting conjunctive use efforts, and public documents produced by the City of Hanford.

The following sections include technical discussions on the District's groundwater. These are intended to provide geologists, engineers, and water managers a greater understanding of the area's stratigraphy, groundwater conditions, and hydrogeologic parameters. The content of this chapter requires a basic understanding of some geologic principles and terminology. Less technical discussions on groundwater management programs can be found in Sections 3-9.

2.1 - Regional Geology

The District is located entirely within the confines of the San Joaquin Valley. The San Joaquin Valley is a large asymmetric structural trough that has been filled with sediments from the Sierra-Nevada Mountains to the east and from the Coast Ranges to the west. In the area of KCWD these sediments, corresponding geologic structures, and the District's location with respect to the recharge from the Kings River control the direction of groundwater flow and the quality of groundwater available to wells. In general, KCWD is underlain by (oldest to youngest) relatively impermeable, metamorphic and igneous basement rocks, unconsolidated deposits-the source of most of the fresh water in the area, old alluvium, young alluvium, and topsoil.

Groundwater Basin

The District boundary overlaps three groundwater subbasins all within the San Joaquin Valley Basin. These are all located in the Tulare Lake Hydrologic Region, an area of 10.9 million acres (17,000 square miles), including all of Kings and Tulare Counties and most of Fresno and Kern Counties. The Tulare Lake Hydrologic Region also has 12 distinct groundwater basins and 7 subbasins. The majority of the District is located in the Tulare subbasin, with smaller portions near the northeast and east boundary located within the Kaweah and Kings subbasins (Figure 8). The San Joaquin Valley Groundwater Basin is bounded on the west by the Coast Range of central California, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada Mountains and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. General information on the San Joaquin Valley Basin and the Kings, Tulare Lake and Kaweah subbasins can be found in the California Department of Water Resources Groundwater Bulletin 118 (2003) update. All three of the groundwater subbasins that overlap Districts boundaries are in a critical state of overdraft. A basin is subject to critical conditions of overdraft when continuation of present water

management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts (DWR, 2003). Specifics on the individual subbasins are provided below. Note that the sub basins do not represent adjudicated ground water basins or strictly physical hydrogeologic units but also embrace jurisdictional boundaries.

Kaweah Groundwater Subbasin

The Kaweah subbasin is bounded by the Kings Groundwater subbasin (north), Tule Groundwater subbasin (south), crystalline bedrock of the Sierra Nevada foothills (east), and the Tulare Lake subbasin (west). Major rivers and streams in the subbasin include the Lower Kaweah and St. Johns Rivers. The Kaweah River is considered a primary surface water source for groundwater recharge to the area (DWR, 2003). In the 1980 California Groundwater Bulletin 118 (DWR, 1980), DWR classified the Kaweah sub-basin as being critically overdrafted. This designation was not re-evaluated by DWR when Bulletin 118 was updated in 2003. (However, recent analysis by Fugro (2007) still shows the basin to be in a state of overdraft). DWR has assigned the subbasin a 'Type B' groundwater budget, which means that enough data is available to estimate groundwater extraction to meet local water needs, but not enough data is available to characterize the groundwater budget. According to DWR (2003), well yields in the Kaweah sub-basin are 1,000 to 2,000 gpm, with a maximum of 2,500 gpm. The total dissolved solids in the groundwater ranges from 35-580 mg/L with an average of 189 mg/L.

Tulare Lake Groundwater Subbasin

The Tulare Lake subbasin is bounded by the Kings-Kern County line (south), California Aqueduct and Kettleman Hills (west), Kings Groundwater subbasin (north), and Kaweah and Tule Groundwater subbasins (east). The southern half of the Tulare Lake Subbasin consists of lands in the former Tulare Lake bed in Kings County. Like the Kaweah subbasin, DWR has assigned the subbasin a 'Type B' groundwater budget. Average annual precipitation is seven inches throughout most of the subbasin and nine inches at the northern margin (DWR, 2003). Well yields in the Tulare Lake subbasin average 1,000 to 2,000 gpm, with a maximum of 3,000 gpm. Total dissolved solids typically ranges from 200 to 600 mg/L with values as high as 40,000 mg/L.

Kings Groundwater Subbasin

The Kings subbasin overlaps the northern parts of the District near the Kings River. The Kings Subbasin is bounded by the San Joaquin River (north), Delta-Mendota and Westside Groundwater subbasins (west), southern fork of the Kings River and several water district boundaries (south), and the alluvium-granitic rock interface of the Sierra Nevada foothills (east). The San Joaquin and Kings Rivers are the two principal rivers within or bordering the subbasin. The Fresno Slough and James Bypass are along the western edge of the subbasin and connect the Kings River with the San Joaquin River. DWR (2003) has assigned a groundwater budget type of 'C' to the subbasin, which indicates a low level of knowledge of any of the budget components for the area.

Average annual precipitation values range from seven to ten inches, increasing eastward.

Previous Studies

Croft and Gordon (1968) studied the hydrogeologic setting of the greater Hanford-Visalia area and presented their findings in a report titled "Geology, Hydrology, and Quality of Water in the Hanford-Visalia Area". This report presents data on the various significant lacustrine lake bed deposits, detailed descriptions of the stratigraphy of the subsurface geology, and the chemical nature of water in the various aquifers. Croft (1972) studied the subsurface geology of the southern San Joaquin Valley and compiled maps and cross sections of the A, C, and E lacustrine clay layers. In December 2003, Fugro West, Inc. prepared a report for KDWCD entitled "Water Resources Investigation of the Kaweah Delta Water Conservation District". The report was revised in July 2007. The purpose of the study was to conduct a detailed geologic and hydrogeologic analysis to evaluate and assess the safe yield of the Kaweah Delta Water Conservation District (KDWCD). The overall purpose of the study was to provide the KDWCD, overlying water purveyors, and Tulare County planning agencies with baseline data to help plan future water supply projects. Several of the maps and findings for hydrologic area No VI produced for the report were used as background data for this GMP. In addition to the regional scale studies above, Provost and Pritchard performed several studies and writes annual reports documenting hydrogeologic conditions and conjunctive use efforts in the vicinity of the Old River channel.

2.2 - Physiography of the District

The San Joaquin Valley, which is the southerly part of the great Central Valley of California, extends from the Sacramento-San Joaquin Delta area on the north about 250 miles to the Tehachapi Mountains on the south. In the vicinity of the District, it is approximately 65 miles wide. The Valley is bordered on the east by the Sierra Nevada Mountains, which range in elevation from about 1,000 feet or less to more than 14,000 feet above sea level. The Coast Range Mountains, which border the Valley on the west, rises to about 6,000 feet above sea level.

The southern end of the San Joaquin Valley, also known as the Tulare Basin, is a closed feature, with surface water flowing out of the basin only in extreme wet periods. Tributary streams drain to depressions, the largest of which is Tulare Lake bed, which according to Page's (1986) interpretation, is located south of the District's boundary. The Kings River, Kaweah River, Tule River, White River, Deer Creek, Lewis Creek and Poso Creek, and, on occasion, the Kern River, discharge into Tulare Lake at times when flows exceed the capacity of foothill reservoirs and the irrigation diversion systems.

The large alluvial plains and fans of the Kings River and the Kaweah River dominate the landscape of the District. The Kings River alluvial plain and fan is the single largest geomorphic feature within the District; representing approximately 80 percent of more of the total land surface area from Cross Creek westward. East of Cross Creek, the

alluvial plain and fan of the Kaweah River dominates the landscape. Small pockets of flood basin deposits are present at the surface in the northeastern, eastern and extreme southern portions of the District. West of the District boundary, in the axis of the Valley, the Kings River separates alluvial fans derived from streams discharging to the valley from the coast ranges from alluvial plains and fans emanating from the east slope of the Sierra Nevada. The low alluvial plains and fans of the Kings and Kaweah Rivers are characterized by surfaces of low topographic relief, rarely exceeding 10 feet except near major streams (Croft and Gordon, 1968). Near the Tulare Lake bed, at the southern portion of the District, the surface is nearly flat and featureless. In alignment with the plain and fan of the Kings River, land in the District generally slopes downward from the northeast to the southwest at three to four feet per mile, with local variations caused by remnants of slough channels. Elevations range from 220 feet msl in the southern part of the District to 300 feet msl in the northeast part of the District near the Kings River.

The Old River of the Kings River is a previous alignment of the Kings River that has been completely blocked from the existing channel (Cole Slough) during large floods. See KRCD Kings River Handbook at p. 21 (5th Printing Sept. 2009). The Old River is now a dry channel that rarely conveys natural flows. Most water in the channel is intentionally diverted into the Old River for groundwater recharge. The Old River has a sandy bottom that is conducive to groundwater recharge; its high percolation rates and proximity to conveyance facilities make it an ideal location for groundwater recharge. The Old River begins south of Peoples Weir (near the existing Apex Ranch Conjunctive Use Project) and extends for several miles until it meets up again with the Kings River.

2.3 - Stratigraphy

The following discussion focuses on significant hydrogeologic units that could have an impact on the groundwater resources within the District. Stratigraphy in the District is documented in several reports. The description below is based primarily on the information provided in Croft and Gordon (1968). The generalized stratigraphic sequence of the District includes the basement complex consisting of consolidated metamorphic and ingenious rocks, unconsolidated deposits, and topsoil.

Basement Complex

The Sierra Nevada basement complex underlies the entire sequence of unconsolidated deposits, extending from the foothills on the east, sloping downward to the southwest at 4^{o} - 6^{o}. The basement complex (from 4,300 feet bgs in the northeast corner of the District to greater than 10,000 feet bgs in the southwest) is assumed to be deep enough that it does not have a significant effect on groundwater supply and conditions, and is not discussed further here. A detailed description of the basement complex can be found in Croft and Gordon, 1968. Marine Rocks are indicated above the basement complex in areas east of the District, but are not shown in cross section by Croft and Gordon (1968) within District boundaries. This does not, however preclude the existence of Marine Rocks at depth beneath the District, but if they are present they are too deep to be of significance to the fresh water aquifer.

Unconsolidated Deposits

An enormous aquifer system lies beneath the District and extends the length and breadth of the San Joaquin Valley. The valley is a broad structural trough, with the Sierra Nevada Mountains on the east and the Coast Range mountains on the west. Consolidated and unconsolidated continental and marine deposits from both the Sierra Nevada and the Coast Range mountains overlie the basement complex. Unconsolidated alluvial deposits make up most of the basin's freshwater aquifer (USGS Water Supply Paper 1999-H, 1972). Croft and Gordon (1968) differentiate the unconsolidated deposits into oxidized and reduced continental deposits, overlain and interfingered with lacustrine and marsh deposits, oxidized and reduced older alluvium, younger alluvium, and flood-basin deposits. All of the unconsolidated deposits thicken and dip to the southwest beneath the district, where the continental deposits and older alluvium grade into the lacustrine and marsh deposits of the Tulare lakebed.

Interspersed within the unconsolidated deposits that comprise the useable aquifer in the region are a number of lacustrine clay layers and marsh deposits that can act as confining beds. The confining bed that has greatest significance to Kings County Water District is known as the Corcoran Clay, or E-Clay. One other significant clay layer that also partially underlies Kings County Water District is the A-Clay. The lacustrine clays are discussed in further detail below. Figure 9 shows the horizontal extent of the Corcoran Clay, as mapped by Davis et. al. 1957, Croft, 1972 and Page, 1986, and the A clay layer, as mapped by Croft, 1972, in the area. Figure 10 shows a generalized geologic cross section of the District. The following discussion is mainly from Croft and Gordon (1968).

Continental Deposits

The continental deposits, both oxidized and reduced, overlie the basement complex. The reduced section is approximately 2,000 feet thick and is composed of arkosic, micaceous, calcareous, and fine to medium grained sand, silt and clay. The unit is moderately permeable and wells completed in it yield large quantities of sodium bicarbonate water. The oxidized section is about 500 feet thick and composed of arkosic, calcareous, deeply weathered silt, sand and clay. The unit is considered poorly permeable and yields little water but the water is of excellent quality.

Lacustrine and Marsh Deposits

The lacustrine and marsh deposits represent deposition in the low energy, lacustrine environment of the ancient Tulare Lake and surrounding marshes. South of the District in the vicinity of the Tulare lakebed the deposits are as much as 3,000 feet thick and form a solid plug of reduced, fossiliferous, gypsiferous clay, silts and fine sand. From the plug of fine sediments several clay layers radiate north and east where they extend into the District and interfinger with the continental and older alluvial deposits. As mentioned above the most significant of these clay layers are the A Clay and the Corcoran Clay. These deposits are poorly permeable and yield little water to wells. The water that is contained in these deposits is of poor quality.

Clay Layers

Although as many as six laterally continuous clay zones have locally been defined in the southern San Joaquin Valley, only the two most prominent of these clay zones known as the Corcoran Clay or E Clay and the A Clay are found to be hydrogeologically significant within the District (Figures 9). The E Clay is one of the largest confining bodies in the area and underlies about 1,000 square miles of the San Joaquin Valley. The beds were deposited in a lake that occupied the San Joaquin Valley trough and which varied from 10 to 40 miles in width and was more than 200 miles in length (Davis et al., 1957).

Corcoran Clay

As mapped by Davis et. al. 1957, the southern two-thirds of the District is largely underlain by the Corcoran Clay, which separates a generally unconfined aquifer system above from a confined aquifer system below (Figure 9). Later interpretation of the Corcoran clay, by Croft (1972), Croft and Gordon (1968), and Page (1986) continued to extend the Corcoran clay further north and east. The latest interpretation by Page in 1986, places the northeastern extent of the Corcoran clay about 4.5 miles further north in a line cutting diagonally through the northeast portion of T17S, R22E near the Old River channel and about 5 miles northeast of Laton. Using Pages extent for the Corcoran Clay places it beneath the entire District, with the exception of the extreme northern part of the District, from about the southern boundary of Apex Ranch south. For the purposes of this section Pages interpretation is used here, as he had access to more E-logs and well completion reports than previous authors.

The published reports mentioned above agree that the Corcoran Clay dips and thickens southwest beneath the District. According to Page, the depth to the top in the northeast portion of the District is about 200 feet bgs and it deepens to as much as 600 feet bgs in the south-southeast part of the District. While information on thickness is incomplete in the District, especially in the northeast, it probably thickens from a few feet in the northeast to about as much as 80 feet thick in the south-southwest portions of the District.

A Clay

As mentioned above the A Clay is the other significant lacustrine clay beneath the District. Of the six mapped lacustrine clay beds it is the upper most of the clay tongues. It occurs 40 to 50 feet below the surface and is from 20 to 50 feet thick. Being younger in age than the other lacustrine clays it is less deformed and while it does dip to the southwest, dip is less pronounced and measured on the order of 40 feet across the District. The eastern extent of the A clay as mapped by Croft (1972) and Croft and Gordon (1968) roughly parallels the Atchison Topeka Railroad tracks from the City of Hanford southward. North of Hanford the eastern extent is shown to veer northwest leaving the District southwest of Laton about 3.5 miles (Figure 9). Being shallow this clay lens can pose problems along the western boundary of the District by limiting the vertical movement of water in the perched aquifer. In a series of wetter years, this can pose a significant impact on farming activities in this area.

Old Alluvium (reduced and oxidized)

The Older Alluvium is a feldspathic blanket of gravel, sand and silty sand that overlies the Continental Deposits, and the lacustrine and marsh deposits, where present, from the Sierra Nevada to the trough of the valley. The unit is primarily derived from the Sierra Nevada and has been divided into a reduced section and an oxidized section. In general it is coarser than the underlying Continental Deposits, but the contact is arbitrary. The entire section of older alluvium has a maximum thickness of about 1,600 feet. The reduced section is considered moderately permeable and the oxidized section is considered highly permeable. The unit as a whole is considered a major aquifer and yields water of sodium bicarbonate to calcium or magnesium bicarbonate type.

Young Alluvium

The Young Alluvium is a recent veneer of fluvial arkosic beds overlying the Continental Deposits and Older Alluvium. The unit consists of gravelly sand, silty sand, silt, and clay deposited along stream/river channels and laterally away from the channels in the easterly portion of the District. Younger alluvium is relatively thin, with a maximum thickness of 40 feet, reaching a maximum depth below ground surface of perhaps 100 feet. The Young Alluvium is generally above the water table and does not constitute a major water-bearing unit. However, in the Hanford-Lemoore area the unit was a major water producing horizon, at least at the date of publication in Croft and Gordon (1968). Soils developed on the Young Alluvium do not show multiple soil horizons (layers) and are generally free of underlying clay subsoil or hardpan. Because percolation rates through the Young Alluvium are moderate to high, this deposit serves as a permeable conveyance system for recharge to underlying water-bearing materials.

Flood Basin Deposits

Flood Basin Deposits include the reduced fine grained materials underlying the Tulare Lake bed, overflow lands, and slough areas in the valley trough. Several pockets of Flood Basin Deposits are found in the District. The main occurrence is along the eastern edge of the District extending from the Kings River to Cross Creek. Other pockets occur south of Cross Creek and in the southern portions of the area. The Flood Basin Deposits are composed of reduced, fossiliferous silt, clay and fine sand less than 50 feet thick. Because of their fine grained nature the Flood Basin Deposits have ramifications for the sighting of recharge basins. Fugro (2007), Plate 24, sighting the Kings County NRCS-soils survey, identifies soils developed on remnants of the flood basin deposits as having very slow infiltration rates and high runoff potential.

Topsoil

According to the Natural Resources Conservation Service Soil Survey for Kings County (2007), soils in the District and vicinity range from coarse sands to heavy clays with the majority being a variety of loam (Figure 6). Soils throughout the vicinity of Kings County Water District are stratified, with interspersed sandy and clayey streaks (Provost and Pritchard, 2001). In general the soils become increasingly finer grained in the central and western portions of the District. These soils were deposited in the valley

trough during flood periods and are derived from mixed granitic and sedimentary rocks from both the Sierra Nevada and Coast Range Mountains. Soils in the eastern portion of the District generally have higher sand content and are derived mostly from granitic Sierra Nevada sediments deposited on alluvial fans. Soils formed on the alluvial plains and fans are generally sandy, permeable, fertile, and free of hardpan, making them generally suitable for irrigated agriculture. In the interfan areas and near Cross Creek the soils are alkaline and less fertile (Croft and Gordon, 1968). The major soil types in the District are Kimberlina fine sandy loam, saline-alkali (23.2%), Nord Complex including the Nord Fine sandy loam (30%) and the Kimberlina saline alkali-Garces complex (6.6%). Other soil types cover less than 4% of the District's area by type and are not named here.

2.4 - Aquifer Characteristics

In KCWD, aquifers occur in perched, unconfined to semi-confined, and confined states. Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. In confined or artesian aquifers, water bearing materials are completely saturated and are overlain by confining materials of low permeability, such as clay and fine silt, and water within the aquifer is under hydrostatic pressure. The hydrostatic head, or pressure, in such an aquifer is reflected by the height above the confining stratum to which water will rise in a well drilled into the aquifer.

Because the alluvial and continental deposits in the District are characteristically heterogeneous in composition, containing individual strata of low permeability that generally exhibit little or no continuity, most aquifer systems are, in fact, semi-confined, becoming increasingly confined with depth. Such aquifers respond to pressure changes over short periods of time, but hydrostatic heads in confined aquifers reach equilibrium with unconfined water tables over extended periods of static, non-pumping conditions.

Specific Yield

Specific yield, often termed storage coefficient in unconfined aquifers, is defined as the volume of water that will drain by gravity from sediments within a designated storage unit if the regional water table were lowered. Conversely, it is also defined as the volume of water to re-saturate the deposits after they are drained.

Page and Leblanc (1969) provide a range of specific yields in the subbasin from 0.002 to 0.36. Fugro (2007) Plate 23, citing Davis et al., 1957 estimated regional specific yield for the entire KDWCD area to depths of 200 feet bgs. The western part of its map covers the majority of the Kings County Water District with the exception of the northern several square miles in the vicinity of Apex Ranch. Considered in an overall picture, the contours of equal specific yield increase across the District from between 0.08 to 0.09 in the northeast to about 0.12 in the south-southeast part of the District. Williamson et al. (1989) used an average of 0.113 in the Kings subbasin for groundwater modeling. Previous estimates by Provost and Pritchard (2001) used an average specific yield

value of 0.11 percent for the upper 570 feet of the unconfined aquifer, which in large part agrees with the published estimates of specific yield.

In the vicinity of Apex Ranch, specific yield values derived from several two-week long onsite pumping tests were estimated to be 0.13. This is a relatively high value but is consistent with coarse-grained nature of the aquifer, likely Young Alluvium, in the upper several hundred feet.

Transmissivity and Specific Capacity

Transmissivity and specific capacity are aquifer parameters used as indicators of the potential yield of an aquifer. Transmissivity is the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic head. Specific capacity is the rate of discharge of a well per unit drawdown.

Transmissivity data of a regional nature is available from the literature and from pumping tests on recovery wells at Apex Ranch. A study by Davis et al., (1964) summarized numerous specific capacity values from Pacific Gas & Electric pump tests performed across the San Joaquin Valley. Using data from over 300 field tests in the KCWD and surrounding areas, they calculated specific capacities ranging from 18 to 59 gpm per foot of drawdown. Thomasson, H. G., et al. (1960) developed an empirical relationship between specific capacity and transmissivity. Their methodology for calculating transmissivity from specific capacity data is presented by Driscoll (1986, in Appendix 16.D). Using these methods, transmissivity values for the District and immediately surrounding areas range from 27,000 to 88,500 gpd/ft. These values of specific capacity and transmissivity are probably valid for the unconfined aquifer, as at the time of the report most wells drilled in the area were most likely completed above the E clay in the unconfined aquifer.

In the vicinity of Apex Ranch, transmissivities derived from several two-week long onsite pumping tests ranged from 90,000 to 145,000 gpd/ft. An average or typical value of 120,000 gpd/ft was recommended (Provost & Pritchard, October 2006).

Of note from the regional study by Davis et al. (1964) is the decrease in specific capacity from the north to the south and from the east to the west. In township T19S, R21E, the regional study by Davis et al. gives a specific capacity of 18 gpm/ft, while in T21S, R22E the estimated value is 59 gpm/ft. These values probably reflect the increase in the amount of finer materials in the aquifer near the Tulare Lake bed and, conversely, the increase in coarse-grained materials higher up on the alluvial plains and fans of the major rivers in the area.

Wells Yields and Depths

Usable groundwater in the District occurs both above and below the Corcoran Clay, and many water wells perforate zones both above and below it, especially in the southern parts of the District. These wells allow significant amounts of inter-aquifer flow between

the upper unconfined aquifer and lower confined aquifer, thereby equalizing piezometric (head) differences.

Information on the depth of wells within the District boundary is sparse. However, several well logs obtained for previous studies indicate that wells in the District typically range from about 200 to as much as 1,500 feet deep. Anecdotal evidence suggests that the depths of new wells in the southern portions of the District tend to be increasing as water levels drop there. At least one well located south of Hanford in T19S, R21E, Section 12 is 2,070 feet in depth (Fugro, 2007). The City of Hanford operates 19 water supply wells ranging in depth from 600 to 1,500 feet deep with well depth determined by water quality. More recent wells drilled by the City of Hanford have been completed to greater depths, perhaps as deep as 2,200 feet.

Provost and Pritchard (2001) estimated well yields within the District to be between 400 to 3,000 gpm, with most wells producing 1,500 to 2,000 gpm. Wells in the City of Hanford have capacities from 575 to 2,500 gpm.

The California DWR (2003) states that well yields in the Kaweah groundwater subbasin range from 1,000 to 2,000 gpm, with a maximum of 2,500 gpm. The same report indicates that well yields in the Tulare Lake subbasin average from 300 to 1,000 gpm, with a maximum discharge of 3,000 gpm. Wells in the Kings subbasin average 500 to 1,500 gpm, with a maximum discharge of 3,000 gpm.

Safe Yield or Perennial Yield and Overdraft

The safe or perennial yield of a groundwater basin is typically defined as the volume of groundwater that can be pumped year after year without producing an undesirable result. Any withdrawal in excess of safe yield is considered overdraft. The "undesirable results" are recognized to include not only the depletion of groundwater reserves, but also deterioration in water quality, unreasonable and/or uneconomic pumping lifts, creation of conflicts in water rights, and depletion of stream flow by induced infiltration. It should also be recognized that the concepts of safe yield and overdraft imply conditions of water supply and use over a long-term period. Previous analysis by Provost and Pritchard (2001) estimated an overdraft of 32,000 AF/year using a base period of 1970 to 1994. The perennial yield, or safe yield, for KCWD was estimated at 194,000 AF/year. Fugro (2007) provided a 'Practical Rate of Withdrawal' for Hydrologic Unit No VI (Table 78) which covers roughly the eastern half of KCWD. The 'Practical Rate of Withdrawal' for that area ranges from 152,400 to 154,300 AF/year.

Groundwater Storage

Defining the useable groundwater reservoir as the unconfined aquifer lying above the E Clay, an estimated groundwater storage capacity can be calculated. The elevation of the base of the E Clay averages about 400 feet below sea-level within the District, with an average thickness of around 80 feet. The average ground surface elevation in the District is about 260 feet, resulting in an average total depth for the unconfined aquifer of about 580 feet. Assuming that it is undesirable to have the water table less than ten feet

from the ground surface, the average thickness of the useable aquifer is around 570 feet. Applying an average specific yield of 0.11, and multiplying by the total District area of 143,000 acres results in an estimated total unconfined aquifer storage capacity of 8,900,000 AF (Provost and Pritchard (2001).

For the period 1993 to spring 2010, average water levels for the unconfined aquifer have declined from 109 ft bgs to 125 ft bgs. Applying the same specific yield of 0.11, groundwater storage in KCWD has declined by about 252,000 AF, or about 14,800 AF/year for the period.

Groundwater Flow

Groundwater contour maps produced for the KCWD consistently show groundwater flows in the unconfined aquifer across the District from the north due to recharge along the Kings River, and from the east generally south of Highway 198. Groundwater outflow typically occurs across the southern boundary of the District towards a persistent depression centered south of the District. Periodically groundwater contours indicate that minor amounts leave the District across the western boundary. Several groundwater depressions and a persistent groundwater ridge along Cross Creek cause local variations to the direction of flow. One groundwater depression is consistently centered immediately west of the eastern boundary of the District, south of Highway 198. The other main groundwater depression is typically located west of Highway 43 about midway between Highway 198 and the southern boundary of the District. The groundwater ridge associated with recharge along Cross Creek appears to cause flow to the east and west, and as the groundwater ridge attenuates southward flow resumes in a southerly direction. Refer to Figure 12 where some of the groundwater flow patterns can be discerned from recent groundwater contours.

Recharge

Fugro (2007), Plate 24, shows the infiltration rates by NRCS soil class for an area covering the majority of the District. According to its map the majority of the District is NRCS Class B. Class B soils have a moderate infiltration rate when thoroughly wetted, and are chiefly moderately deep to deep, moderately well drained to well drained, and have a moderate rate of water transmission. Minor portions of the District along the eastern boundary are classified as very slow and small pockets of soils with high infiltration rates are found along stream courses and river channels throughout the District. Natural recharge is facilitated almost exclusively along the Kings River channel and Cross Creek.

Currently, the District is engaged in numerous intentional recharge efforts with plans on expanding the current recharge capabilities. Figure 5 shows the current distribution of recharge basins. Efforts are currently underway to expand recharge capabilities in the District, in and around Hanford, and at other locations as opportunities arise. Currently, the District is in the process of constructing the 36.5 acre Garner Recharge Basin along Highway 198 east of Hanford.

2.5 - Groundwater Levels

In the early 1900's, regional groundwater levels were typically within ten feet of the ground surface. As land was brought into agricultural production, and with the advent of deep well turbine pumps, groundwater levels began to decline. By 1950, water levels had begun a sharp decline that continued into the mid-1970's. In this period a significant portion of the unconfined aquifer was dewatered and a large cone of depression centered on lands south of the District.

Groundwater levels in KCWD were fairly stable prior to 1987, but have seen a steep decline since then. Water levels have continued to fluctuate in response to drought and flood years. Recently, water levels have dropped significantly due to a 3-year long drought, but prior to the drought water levels raised across the District for a period of several years (Figure 11). Water level data for several representative wells in the District (called Indicator Wells) can be found in Figure 14. Information from the Indicator wells has traditionally been used by the District to provide an early indication of District wide water levels prior to preparation of the semi-annual groundwater contour maps.

Water levels in wells tapping the confined aquifer (below the E Clay), also declined through the 1950's and 60's. However, due to the confined nature of the aquifer, these declines track the piezometric or pressure surface of the groundwater, and therefore do not indicate a physical reduction of water in storage in the confined aquifer. This downward trend reversed dramatically in the mid-1960's in response to initiation of delivery of imported surface water from the USBR's Central Valley Project (CVP). This surface water supply resulted in decreased pumping from beneath the E Clay in regions west of KCWD. Water levels in wells pumping from the confined aquifer once again began to decline in the early 1990's when imported water supplies declined as a result of an extended drought and regulatory restrictions on Delta exports. Recent reductions in surface water deliveries from the CVPIA to famers west of the District has again caused increased pumpage of groundwater there with attendant drops in water levels.

Figure 16 shows a time series of groundwater elevations along a northeast-southwest cross section. The data covers a period of approximately 40 years and illustrates the differences in groundwater level changes in different parts of KCWD.

The most recent groundwater contour maps were prepared by KCWD in spring 2010. Water levels in wells pumping from the unconfined aquifer ranged from about 240 feet in elevation in the northwest corner of the District to as deep as – 40 feet below sea-level on the District's southern edge (about 50 feet to 275 feet bgs) (Figure 12). Of note is the fact that regionally water levels in the vicinity of the Kings River have not seen as significant drops when compared to wells in the southern portion of the District. This would indicate the Kings River, even in dry periods, has a moderating influence and can be considered a recharge boundary.

2.6 - Land Subsidence

Some investigators believe that groundwater withdrawal may cause land subsidence. According to Ireland et al. (1984), land subsidence from 1926 to 1970 in KCWD has likely been no more than four feet. Subsequent work by Swanson (1998) indicates that, with the availability of new surface water supplies in the San Joaquin Valley in about 1970, rates of subsidence were substantially reduced. From 1925 to 1995, such subsidence occurred only in drought years and in local areas where historic low water levels were exceeded. Currently, the Kings River Conservation District is establishing a regional subsidence monitoring program and KCWD will endeavor to aid its effort. Subsidence is not currently seen as having a significant impact to the District since there is no evidence that recharge to the aquifers in wet years has been impeded. Local water infrastructure in use since the 1870's has not been damaged by the expected effects of subsidence had it occurred.

2.7 - Groundwater Quality

Groundwater quality in KCWD is known only from limited testing. However, the chemical quality of both surface water and groundwater in the District is generally excellent for irrigation, and satisfactory for municipal and industrial use, although there may be some localized problems. The quality of groundwater is expected to remain satisfactory in view of the excellent quality of the replenishment water. The quality of runoff from the Kings River, which furnishes most surface supply to the District, is very good to excellent quality, typically around 50 mg/L Total Dissolved Solids (TDS). Overall groundwater quality has not appeared to change significantly over the years and is generally better on the east side of the District (Provost and Pritchard, 2001). The poorer quality groundwater on the west side of the District is apparently advancing out of the District (Provost and Pritchard, 2001).

Generally, water is considered suitable for agriculture if TDS is less than 700 mg/L (Cherry, 1979). According to DWR (2003), TDS in the Kaweah Groundwater subbasin averages 189 mg/L with a range from 35 to 580 mg/L, in the Tulare Lake subbasin TDS averages 200-600 mg/L with a wide range from 200-40,000 mg/L, and in the Kings subbasin TDS averages 200-700 mg/L with a range from 400-2,000 mg/L. In 1997, electrical conductivity was measured in 167 wells across the District. Electrical conductivity from this one time sampling event averaged 395 uS/cm (~275 mg/L) and ranged from 50 uS/cm to 1,900 uS/cm (~35 to 1,330 mg/L).

Site specific information is available for the City of Hanford, 2009 Consumer Confidence Report, and from water quality testing at the Apex Ranch Conjunctive Use Project. Examination of these water quality results gives an indication of the change in water quality from the north part of the District to the central part of the District. Additionally, water in the Apex Ranch area is from the unconfined aquifer while wells operated by the City of Hanford withdraw water in part from below the Corcoran clay. The City of Hanford 2009 Consumer Confidence Report includes information on the local groundwater quality. Results from the 2009 sampling of the City's water wells show

violations of the state Drinking Water Standards in 6 active wells for arsenic. Ranges in water quality parameters included the following:

- Total Dissolved Solids: 180-560 mg/L
- Specific Conductance: 250-990 uS/cm
- Arsenic: ND-73 ug/L

The City's water supply also has sulfur in some areas that causes odor problems. Zone testing done on test holes for the City indicate that deeper water does not have as much arsenic. This in part explains why the City's wells have been increasing in depth. However it does appear as though the deeper wells do have higher salinity water than the shallower wells.

Water Quality has been monitored at Apex Ranch Conjunctive Use Project since 2003. Typically TDS ranges from about 100 to 280 mg/L, and electrical conductivity ranges from 124 to 390 uS/cm. The higher range in values is from on site irrigation wells that are shallower than project recovery wells. Arsenic has ranged from <2 to 10 ug/L. Compared to water from the City of Hanford, the water in the Old River area has lower concentrations of salts and arsenic. This change is likely due to the close proximity of the wells in the north part of the District to the source of recharged water from the Kings River. Additionally, as the water flows in the subsurface from the north to the south it is likely picking up salt in transit.

3 - BASIN MANAGEMENT OBJECTIVES

Basin Management Objectives (BMOs) are broad goals for improving the management of a local groundwater basin. The following BMO's were developed by the KCWD to address its specific groundwater needs and challenges:

1. Stabilize Groundwater Levels. Stabilize average long-term groundwater levels to a District average depth of 110 feet below ground surface by 2025 to prevent the loss of groundwater reserves, and prevent the need for well deepening or the installation of new wells. This would be achieved through a combination of water conservation measures, direct groundwater recharge, in-lieu groundwater recharge (importing surface water) and groundwater conjunctive use projects.

2. Prevent All Surface Water Exports. Prevent the export of water managed by several Ditch Companies by purchasing the Ditch Company stock and selling the water to growers within the District. This will help to reduce reliance on the groundwater supplies and reduce groundwater overdraft.

3. Import New Surface Water Supplies. Import as much as 10,000 AF/year of new surface water above historical deliveries. In order to accomplish this objective new recharge basins and delivery systems will need to be built.

4. Increase Groundwater Storage Potential. Increase the District's capability to temporarily store and recover an additional 15,000 AF of groundwater through the development of more conjunctive use projects.

5. Increase Adaptive Management Practices. Increase Adaptive Management capabilities to adjust to changes in the timing and flow of surface water through increased water conservation efforts, conjunctive use efforts, and on going public education.

6. Prevent Land Subsidence. Prevent land subsidence by 2030 that may cause reduction in groundwater storage space and damage water delivery infrastructure through efficient use of groundwater supplies, increased recharge, and full utilization of surface supplies.

7. Prevent Groundwater Degradation. Prevent groundwater degradation by protecting groundwater through proper well construction and abandonment, proper use of agricultural amendments, importing clean high quality surface water, and preventing intrusion of poor quality groundwater from neighboring areas, specifically from the west.

8. Maintain Good Groundwater Quality for Agricultural Irrigation. Maintain suitable groundwater quality at values less than 700 ppm for agricultural irrigation.

9. Increase Knowledge of Local Geology and Hydrogeology. Increase knowledge of the local geology and hydrogeology through technical studies, subsurface investigations, water quality testing, water level monitoring, and land surface monitoring. Gain a better understanding of regional groundwater quality, groundwater overdraft, and groundwater flow conditions. Create a numerical groundwater model and detailed water balance based on the information gained from studies and investigations. Seek funding for these investigations through State and Federal grant programs.

10. Maintain/Strengthen the District's Authority for Local Groundwater Management. Solidify the District's position and authority as the manager of local groundwater resources, provide better representation for the District growers on groundwater issues, and prevent the State from taking over control of the local groundwater resources, controlling withdrawals, etc.

All existing and on-going activities described in Sections 4-9 will be maintained, unless stated otherwise. (In Sections 4-9 the Existing Activities are not repeated under Planned Actions, even though they will be continued in the future).

4 - STAKEHOLDER INVOLVEMENT

4.1 - Groundwater Advisory Committee

A Groundwater Advisory Committee (GAC or Committee) was formed in 2009 to assist with updating this GMP. The Groundwater Advisory Committee (GAC) is comprised of the District Manager, District Engineer and KCWD Board of Directors. The KCWD Board of Directors is comprised of local farmers and represents the local community. They are familiar with the local and regional water issues and are best suited to serve as the primary voice on the GAC. The GAC offered several useful and insightful comments that were incorporated into this GMP. The GAC will also monitor and evaluate the technical progress made in achieving the goals of this GMP.

Existing Activities

Assisted with the development of this GMP.

Planned Actions

The Committee will attempt to hold special groundwater sessions at monthly Board meetings annually, or more frequent if deemed appropriate, and will have the following responsibilities:

- Review trends in groundwater levels and available information on groundwater quality;
- Evaluate the effectiveness of current groundwater management policies and facilities;
- Evaluate and respond to claims from landowners that their wells are being impacted by District operations;
- Discuss the need for new groundwater supply/enhancement facilities;
- Educate landowners on groundwater management issues;
- Assess the overall progress in implementing the programs outlined in the GMP;
- Recommend updates or amendments to the GMP;
- Identify regional and multi-party groundwater projects;
- Review and comment on the Annual Groundwater Report; and
- If needed, form special committees or task forces to undertake special groundwater management tasks.

4.2 - Relationships with Other Agencies

The District is located in the Tulare, Kaweah and Kings groundwater sub-basins, which extend beyond many political boundaries and includes other municipalities, irrigation districts, water districts, private water companies, and private water users (see Figures 2, 3, 4 & 5). This emphasizes the importance of inter-agency cooperation, and the District has historically made efforts to work conjunctively with many other water management agencies. The groundwater resource is managed on a cooperative basis with agencies in areas that overlap KCWD boundaries.

Below is a list of some organizations that the District has worked with in managing the local groundwater:

- Kaweah Delta Water Conservation District
- Kings River Water Association
- Upper Kings Basin IRWMP
- United States Bureau of Reclamation
- Department of Water Resources
- Association of California Water Agencies
- City of Hanford
- Lakeside Irrigation Water District
- Alta Irrigation District
- Consolidated Irrigation District
- Laguna Irrigation District
- Kings County
- Local Ditch Companies
- Kings River Area Property Owners group

A description of each organization and its role in managing groundwater in KCWD is provided below.

Kaweah Delta Water Conservation District

The Kaweah Delta Water Conservation District (KDWCD) was formed in 1927 under provisions of the Water Conservation District Act of 1927 for the purpose of conserving and storing waters of the Kaweah River and for conserving and protecting the underground waters of the Kaweah Delta. The District includes lands in both Tulare County and Kings County. The total area of the District is approximately 340,000 acres. Refer to Figure 2 for a map showing the boundaries of KDWCD in and near KCWD.

KDWCD contains multiple local agencies that provide various types of water services. These member agencies include:

- California Water Service Company
- City of Farmersville
- City of Lindsay
- City of Tulare
- City of Visalia
- City of Woodlake
- Consolidated People's Ditch Company
- Kings County Water District
- Lakeside Ditch Company
- Lakeside Irrigation Water District
- St. Johns Water District

- Stone Coral Irrigation District
- Tulare Irrigation District
- Ivanhoe Irrigation District

KCWD has cooperated with the KDWCD on many projects, including the KDWCD GMP (see Section 1.6), KDWCD Numerical Groundwater Model (see Section 9.2), the KDWCD Integrated Regional Water Management Plan (in process), and groundwater monitoring efforts. In 2010, the KCWD General Manager was also the President of the KDWCD.

Kings River Water Association

The District is a stockholder in People's Ditch Company and Last Chance Water Ditch Company. Both of these Companies are members of the Kings River Water Association (KRWA), a 28-member group of water agencies that was formed in 1927 to administer and manage water flows on the Kings River. Through the participation in these mutual water companies the District can participate and receives benefits of KRWA membership which include conflict resolution mechanisms, and improved coordination among member agencies. The KRWA opens lines of communication so that members can work together effectively to utilize, trade, and transfer waters from the Kings River.

Upper Kings Basin IRWMP

KCWD is a member agency in the Upper Kings Basin Integrated Regional Water Management Plan. KCWD regularly attends its meetings and participated in other efforts and projects.

USBR/DWR

KCWD currently participates in the Semi-annual Groundwater Measurement Program administered by the USBR. This program requires KCWD to take water level measurements from specified wells two times a year and share the data with USBR. USBR then shares this data with the DWR. KCWD has also historically applied for and received grants from the DWR that fund water management studies and construction of water infrastructure.

Association of California Water Agencies

KCWD is an active member of the Association of California Water Agencies (ACWA). ACWA fosters cooperation among all interest groups concerned with stewardship of the State's water resources. KCWD attends the ACWA annual meeting and benefits from the educational and informational services that ACWA offers.

Lakeside Irrigation Water District

The Lakeside Irrigation Water District (LIWD) and KCWD have historically pursued joint projects including the Garner Recharge Basin which is currently under construction. The basin is being excavated and the material removed is being used in the widening of State

Highway 198. This Basin will have a total capacity of about 354 AF. LIWD also shares groundwater level data with KCWD.

Alta Irrigation District/Consolidated Irrigation District

Alta Irrigation District and Consolidated Irrigation District both share groundwater level data with KCWD, and sell surplus surface water to KCWD.

Laguna Irrigation District

Laguna Irrigation District shares groundwater level data with KCWD that is used to prepare semi-annual groundwater contour maps.

Kings County

Kings County includes a Water Commission that reports to the County Board of Supervisors. The Water Commission often asks KCWD for advice and input.

Local Ditch Companies

Several Ditch Companies are located in KCWD including Peoples Ditch Company, Last Chance Water Ditch Company, and Lakeside Ditch Company. KCWD is a major stockholder in each of these companies. The Ditch Companies keep KCWD apprised of water supply and delivery data. KCWD also collaborates with them on flood control, spillwater capture, and groundwater recharge projects.

Kings River Area Property Owners

In 2008, several landowners in KCWD formed Kings River Area Property Owners (KRAPO) due to their concerns that the Apex Ranch Conjunctive Use Project was adversely impacting their groundwater levels. KCWD has met with KRAPO on several occasions to resolve these issues. Refer to Section 9.6 – Dispute Resolution for more information on KRAPO.

Existing Activities

- On-going agreements, cooperative agreements and projects with other agencies mentioned above.

Planned Actions

- Implement multi-agency projects identified in the KDWCD and Upper Kings IRWMP that will benefit KCWD and the region's groundwater resources.

4.3 - Plan to Involve the Public and Other Agencies

The District is already involved with many neighboring and regional agencies on groundwater management projects. Nevertheless, KCWD is always interested in building new relationships with other agencies that share the same groundwater basins. KCWD will also strive to involve the public in groundwater management decisions. Additional

cooperative relationships can be achieved through the sharing of data, inter-agency committees, interagency meetings, memorandums of understandings, formal agreements, and collaborations on groundwater projects.

Existing Activities

- Public outreach efforts described in sections 1.5 and 4.2.

Planned Actions

- Hold monthly Groundwater Advisory Committee meetings that are open to the public.
- Provide copies of the annual groundwater reports to the public and interested public agencies at their request.
- Develop further relationships with Fresno Irrigation District, and other Kings River Contractors, who currently donate Kings River water to fish flows, and would have the opportunity to recover them in existing or an expanded conjunctive use projects.

5 - MONITORING PROGRAM

Optimal use of the groundwater resource is dependent on obtaining good basic data respecting both geology and hydrology. The purpose of this element of the Plan is to characterize the conditions within the groundwater basin, both to document the accomplishments of the GMP and to identify and implement specific programs, as needed, to reflect changing conditions in the basin.

This section discusses monitoring of groundwater levels, groundwater quality, land surface subsidence, and surface water. Monitoring is considered critical to future management decisions, and the District's monitoring program is intended to:

1. Provide warning of potential future problems;
2. Use data gathered to generate information for water resources evaluations;
3. Develop meaningful long-term trends in groundwater characteristics; and
4. Provide data comparable from place to place in the District

The District's monitoring program is divided into two distinct monitoring programs: 1) Apex Ranch Conjunctive Use Project Monitoring Program and 2) District wide Monitoring Program. Each is discussed below.

5.1 - Apex Ranch Conjunctive Use Project Monitoring

A Groundwater Monitoring Committee (Committee) of local landowners was established in 2002 for monitoring and providing guidance on the management of the existing Apex Ranch Conjunctive Use Project. The goal of the Committee is to provide oversight to the District regarding the project operations. The Committee provides guidance to the District in response to local concerns based on reviews of the monitoring data and project operations. The Committee also reviews and discusses the Annual Report of Operations (see Section 9.3). Meetings are held as needed to keep the Committee informed of the project's operations.

The objectives of the Apex Ranch Conjunctive Use Project monitoring plan are to provide the District and project monitoring committee with documented information to accomplish the following:

1. Determine long-term recharge rates;
2. Evaluate operation and maintenance procedures to maintain or enhance recharge rates;
3. Evaluate the effect of groundwater recharge on shallow groundwater levels beneath and adjacent to the facility;
4. Determine the impact of recovery well pumping on groundwater levels in nearby wells;

5. Evaluate the effect of groundwater recharge on local groundwater quality; and
6. Determine the volumes of water delivered, recharged, recovered, and left in the aquifer.

Specific details of groundwater level and groundwater quality monitoring at Apex Ranch are discussed below in Sections 5.2 and 5.3. KCWD has also worked with KRAPO in revising the monitoring plan in the past few years (see Section 9.6).

5.2 - Groundwater Level Monitoring

The District began routinely measuring groundwater levels in 1950's. Through cooperative efforts between the District and several other public agencies KCWD now monitors groundwater levels in 230 to 280 wells each spring and fall, with more frequent monitoring in and around the Apex Ranch Conjunctive Use Project. Figure 13 illustrates the location of wells (KCWD owned and privately owned) that are monitored by KCWD in the District wide monitoring program. Some of the wells are located outside of the KCWD border in neighboring Districts. Appendix C includes a list of attributes for these wells.

Apex Ranch Groundwater Level Monitoring

Groundwater levels are monitored at Apex Ranch Conjunctive Use Project in a series of recovery wells, monitoring wells, and peizometers, and offsite wells that reflect conditions surrounding the project (nearby and down gradient). Currently, the monitoring network consists of 40 to 45 local wells. Groundwater levels are measured in the wells in the spring and fall of every year, including years when no recharge or recovery operations are performed. Several of the monitoring wells, both onsite and offsite, are equipped with data loggers designed to measure the pressure from a water column. Continuous measurement data are recorded throughout the year using the data loggers. Data from these loggers provide the backbone of the project's monitoring. During project operations, monitoring well levels are manually measured each week to check groundwater conditions and validate data logger readings.

Recently members in the Kings River Area Property Owners Association (KRAPO) have maintained that project recovery operations have adversely affected water levels in their wells. KRAPO is a group of local landowners near the Project formed out of concern for the local groundwater resources in the area. KCWD is in ongoing discussions with KRAPO on how to best monitor and operate the project. In response to concerns put forth by KRAPO, KCWD instituted the Monitoring and Mitigation Plan for the 2009 Summer Recovery Pumping Operations and performed an extended aquifer test using local wells as observation wells.

District-wide Groundwater Level Monitoring

KCWD collects groundwater levels in as many as 280 wells each spring and fall (Figure 13). Typically, there is water level information from about 230 wells in the spring and as many as 280 wells in fall. The data obtained in the spring (normally in February and March) reflects the "seasonal high" water table, as the measurements are made prior to pumping for pre-irrigation. The fall measurements (normally obtained in October) are taken after a full season of crop irrigation pumping. KCWD also collects groundwater level data from neighboring agencies, so they understand groundwater conditions on its borders better. The District uses this data to generate semi-annual groundwater contour maps (elevation and depth to water) and calculate the change in aquifer storage. Refer to Figures 12 for the most recent groundwater contour map.

Sharing of Groundwater Level Data

KCWD currently participates in the Semi-annual Groundwater Measurement Program administered by the USBR. This program requires KCWD to take water level measurements from specified wells two times a year and share the data with USBR.

KDWCD Monitoring

KDWCD performs groundwater level monitoring on a regional scale. KDWCD has an extensive monitoring network that was initially established in the 1950's. This network has been maintained and improved in a continuing effort to provide reliable information for annual and long-term assessment of groundwater conditions. The KDWCD prepares semi-annual maps of groundwater depth, groundwater elevations, and annual change in groundwater depth. This data is useful to KCWD for assessing groundwater inflow and outflow, and assessing the health of regional groundwater supplies. The groundwater contour maps use a lower density well network than KCWD uses, and therefore the District still sees value in generating its own groundwater contour maps.

Existing Activities

- Measurement of groundwater levels each spring and fall.
- Each year create groundwater contour maps (elevation and depth to water for Spring and Fall) for the perched aquifer above the A Clay and unconfined aquifers, and calculate the change in groundwater storage.
- Review regional groundwater contour maps and hydrographs prepared by KDWCD each year.

Planned Actions

- Periodically review the monitoring network to determine if it provides sufficient areal coverage to evaluate groundwater levels.
- Protect wells in monitoring program from being abandoned.

- Encourage landowners and developers to convert unused wells to monitoring wells. Inform them through the District educational outreach programs that their abandoned well(s) could be useful to KCWD.
- Maintain at least the same number of wells in the monitoring network by constructing monitoring wells, or adding new private wells to the network when existing wells are taken out of the monitoring network.
- Seek grant funds to install dedicated monitoring wells, including nested wells that measure groundwater levels above and below the A Clay and Corcoran Clay.

5.3 - Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect of groundwater management in KCWD. Groundwater monitoring efforts serve the following purposes:

1) Spatially characterize water quality according to soils, geology (above and below the Corcoran Clay), surface water quality, and land use;
2) Establish a baseline for future monitoring;
3) Compare constituent levels at a specific well over time (i.e. years and decades);
4) Determine the extent of groundwater quality problems in specific areas;
5) Identify groundwater quality protection and enhancement needs;
6) Determine water treatment needs;
7) Identify impacts of recharge and banking projects on water quality;
8) Identify suitable crop types that are compatible with the water characteristics; and
9) Monitor the migration of contaminant plumes.

The District has only performed limited groundwater quality monitoring in the past, and has relied on private landowners and other agencies for groundwater quality data. As there are very few water quality concerns in the District, this approach has generally provided adequate information to monitor and manage the groundwater quality. A discussion on groundwater quality monitoring by the District, landowners, and other agencies is provided below.

Apex Ranch Groundwater Quality Monitoring

Groundwater quality is monitored at the Apex Ranch project according to the following schedule:

Table 5.1 - Water Quality Monitoring Schedule for the Apex Ranch Conjunctive Use Project

Constituent	Shallow Monitor Wells		Recovery Wells	
	Spring	Fall	Two weeks after pumping	One week prior to stopping
EC	X	X	X	X
TDS	X	X		X
pH			X	X
Nitrate				X
Iron				X
Mn			X	X
As			X	X
DBCP				X
EDB				X
Gross Alpha				X

The results to date have shown that the recharge has little to no affect on groundwater quality. As a result, groundwater quality monitoring at Apex Ranch may be curtailed in the future.

Landowner Monitoring

Many landowners test the water quality of their domestic and irrigation wells on a regular basis. Some landowners will provide the test results to KCWD, however, the results are proprietary, and the landowners typically ask that KCWD use the data for its information only and not release it to the general public.

Other Agency Monitoring

Numerous other agencies play important roles in the monitoring and mitigation of groundwater quality. These agencies include the Regional Water Quality Control Board, Environmental Protection Agency, Department of Toxic Substances Control, Kings County Department of Public Health, USGS, and State Water Resources Control Board. KCWD makes an effort to collect and review pertinent water quality data published by these agencies.

Existing Activities

- Test the groundwater quality in and near the Apex Ranch Conjunctive Use Project.
- Regularly collect new water quality information from other agencies and review it to identify any impending groundwater quality problems.

Planned Actions

- Protect wells in monitoring program from being abandoned.
- Measure electrical conductivity at all monitoring wells every five years in conjunction with groundwater management plan updates.
- Assess the adequacy of the groundwater quality monitoring network annually.
- Install ten nested monitoring wells strategically located throughout the District, with the ability to sample groundwater above and below the Corcoran Clay (see Appendix D for details).
- Sample the water quality in dedicated monitoring wells for selected constituents annually.

5.4 - Groundwater Monitoring Protocols

Monitoring protocols are necessary to ensure consistency in monitoring efforts and are required for monitoring evaluations to be valid. Consistency should be reflected in factors such as location of sample points, sampling procedures, testing procedures, and the time of year when the samples were taken. Without such common ground, comparisons between reports must be carefully considered. Consequently, uniform data gathering procedures are practiced by the District. The District has developed water level and water quality monitoring protocols, which can be found in Appendix E.

Existing Activities

- Use the District's protocols when performing groundwater level and groundwater quality monitoring.
- Perform annual calibration of water level sounder and other field sampling equipment.

Planned Actions

- Update groundwater monitoring protocols according to State and Federal guidelines.

5.5 - Surface Water Monitoring

KCWD uses surface water originating from the Kings River, Kaweah River and San Joaquin River. KCWD has no control over the timing and quantity of these surface water deliveries. Detailed monitoring of these water supplies is also performed by other agencies, which are described below.

Kings River. The Kings River Water Association is a private organization that serves as the steward of the Kings River. KRWA oversees Kings River entitlements and deliveries, and helps to protect the river's water quality.

San Joaquin River. San Joaquin River Water is stored in Millerton Lake and impounded by Friant Dam. The USBR operates Friant Dam and monitors water releases, reservoir levels, and water quality. San Joaquin River Water is delivered to KCWD from the Friant-

Kern Canal into Kings River. The Friant Water Authority (FWA) monitors flow rates in the Friant-Kern Canal, diversions to KCWD, and canal water quality.

Kaweah River. Kaweah River water is monitored by the Kaweah and St. Johns River Association (Association). The Association monitors river flows, river stage, deliveries to KCWD, and water quality.

Southern San Joaquin Valley Water Quality Coalition. This Coalition monitors surface water (irrigation and stormwater) throughout the entire Tulare Lake Basin.

Due to the efforts of these other agencies, KCWD has not had a need to monitor the quality of its surface water sources. However, KCWD regularly reviews the data and monitoring reports prepared by KRWA, FWA, USBR and the Association with the primary goals of understanding the long-term hydrology and water availability, and monitoring changes in water quality that could affect crops or groundwater quality.

Existing Activities

- Regularly review hydrologic and water quality data for the Kings, San Joaquin and Kaweah Rivers.
- Cooperate with the Southern San Joaquin Valley Water Quality Coalition in monitoring surface waters.

Planned Actions

- Monitor changes to surface water quality that could directly affect groundwater quality.

5.6 - Land Surface Subsidence Monitoring

Aside from several computer models, regional scale studies of subsidence in the central San Joaquin Valley have not been completed since the USGS published a report by R.L. Ireland (1986) titled Subsidence in the San Joaquin Valley, California, as of 1983. Since that time information on subsidence is limited to data derived from surveys completed along the San Luis Canal by Department of Water Resources, Precise Survey Unit, Delta-Mendota Canal and the Outside Canal and unpublished profiles of State Highways 152 and 198 between State Highways 99 and Interstate Highway 5. DWR compiled data for 6 extensometers from 1984 to 1998, on the west side of Fresno County and more recent data can be obtained from Continuous Global Positioning System (CGPS) stations but little information is available in the Kings County regional area. Subsidence has not been a problem within the District since gravity flow water infrastructure, including 1000's of miles of canals and laterals, in place for 130 years (or more) continues to function as built.

Greater groundwater pumping could theoretically result in land subsidence across a broad area, resulting in aquifer compaction and loss of storage capacity, and cause adverse effects to surface features such as canals, flood control systems, and water supply

pipelines which rely on gravity flow. The greatest threat to land subsidence is in the southern portion of the District where groundwater pumping is the highest and subsurface geologic conditions are conducive to land subsidence.

Currently, land subsidence is not a major problem in KCWD. KCWD staff and landowners have not observed any obvious signs of subsidence to irrigation facilities. However, if surface water rights are reduced and demand from groundwater grows, there is the possibility of land subsidence. If subsidence occurs, then some residual subsidence may continue to occur for several years. Lands within the District will be observed for land subsidence, and, if land subsidence is observed and becomes a problem, KCWD will attempt to determine the cause of the subsidence, and, if necessary, this Plan will be amended to include preventative and mitigative measures. For now, a practical and sensible approach includes importing as much surface water as possible to minimize groundwater pumping.

Existing Activities

- None

Planned Actions

- Periodic resurvey of control points, local benchmarks, water control structures and wells to check for land subsidence. The control points and local benchmarks will be checked relative to High Precision Geodetic Network benchmarks.
- Participate in any regional efforts to monitor and evaluate land subsidence.
- Pursue funding to construct and operate an extensometer within the District boundary.
- Educate local growers on the potential for land subsidence and visual indicators of possible subsidence.
- Review published information by others such as the USGS, DWR, USBR and CalTrans on local subsidence findings.
- Annually check local continually operating global positioning stations (CGPS) for indications of land subsidence.

6 - GROUNDWATER RESOURCES PROTECTION

6.1 - Well Abandonment

Proper destruction of abandoned wells is necessary to protect groundwater resources and public safety. Abandoned or improperly destroyed wells can result in contamination from surface sources, or undesired mixing of water of different chemical qualities from different strata. This is especially important in KCWD because part of the District has a confined aquifer, and perched aquifers often have water high in salinity.

The administration of a well construction, abandonment and destruction program has been delegated to the Counties by the State legislature. Many Counties have adopted a permitting program consistent with Department of Water Resources Bulletin 74-81 for well construction, abandonment, and destruction. The County of Kings has adopted a Well Ordinance that addresses well destruction and establishes requirements for destroying or abandoning wells. The primary responsibility for remedying defective or abandoned wells falls on the landowner and in those cases of non-compliance, the County has the authority to take necessary action to abate unsatisfactory conditions.

The District will properly abandon its own wells when they are no longer useful. In addition, the District will encourage landowners and developers to properly abandon their wells, or preferably, convert unusable wells to monitor wells so that they can become a part of the District's groundwater monitoring program.

Before abandoned wells are converted to monitoring wells they will be evaluated for suitability, including their condition, total depth, perorated interval, etc.

Existing Activities

None

Planned Actions

- When no longer in use, destroy any District owned wells according to County and State standards.
- Educate landowners through the public outreach programs about well abandonment standards, and that abandoned wells could be useful to KCWD as monitoring wells.
- When possible, convert unusable production wells to monitoring wells.
- Meet with the County of Kings to discuss a partnership whereby KCWD would be informed of any landowner that has filed a permit to abandon a well, so KCWD can ask them if the well can be converted into a monitoring well.

6.2 - Wellhead Protection

Need for Wellhead Protection

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the well head. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Furthermore, since wells can be a direct conduit to the aquifer, they must be properly destroyed and abandoned or they will provide an unimpaired route for pollutants to enter the groundwater, particularly if pumping equipment is removed from the well and the casing is left uncapped. Well Abandonment is discussed in Section 6.1.

In the past, wells were commonly contaminated from chemigation systems that allowed the chemicals to flow back into the pump column. This potential contamination can be reduced by installing a check valve on all piping systems that include a chemigation system.

Wellhead Protection Policy

Wells constructed by the District have been, and will continue to be, designed and constructed in accordance with DWR Bulletins 74-81 and 74-90 and the Kings County Well Ordinance. In addition, the District will encourage landowners to follow the same standards for privately owned wells. The DWR Bulletins and County standards provide specifications for the following:

- Methods for sealing the well from intrusion of surface contaminants;
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism;
- Site grading to assure drainage is away from the well head; and
- Set-back requirements from known pollution sources.

Wellhead Protection Area

As defined in the Federal Safe Drinking Water Act Amendments of 1986, a wellhead protection area (WHPA) is “the surface and subsurface area surrounding a water well or well field supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.” The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on geology, pumping rates, and well construction. Private agricultural wells are randomly and fairly closely spaced throughout the District. The District encourages growers to treat

land within 200 feet of any well as a wellhead protection area.

As Kings County Water District does not provide drinking water to the public, Wellhead Protection Areas are not currently applicable to this plan. Depending on the relationship developed with the City of Hanford and Armona Community Services District, delineation of WHPA's may be addressed at a later date.

Existing Activities
None

Planned Actions

- Provide wellhead protection on all newly constructed KCWD wells according to County and State standards.
- Through landowner education efforts, encourage local growers to incorporate proper wellhead protection into all new wells, and retrofit old wells with proper wellhead protection.

6.3 - Saline Water Intrusion

Saline water intrusion occurs when a plume of saline groundwater migrates into an aquifer of higher quality water. This commonly occurs in coastal areas, in areas with large perched saline aquifers, or in areas were deep wells pump saline connate water from below fresh water.

Salt accumulation in surface water and groundwater in the Central Valley is a natural process inherent to lands with semi-arid to arid climates, enclosed basins, or reduced or impeded drainage. Salt accumulation in surface water and groundwater can impact and eventually eliminate most beneficial uses. Salt accumulation can be exacerbated by a wide variety of human activities including irrigation, importation of surface water, application of fertilizer (including manure and biosolids) and pesticides, land disposal of wastes including those from food processing facilities, wineries, municipal wastewater treatment plants, discharge of urban storm water runoff, and use of recycled wastewater.

Currently, there are no known saline groundwater problems in KCWD. The District is not near the coast and connate saline water is generally too deep to be tapped by wells in the area. Upconing of saline water from deep groundwater pumping is unlikely, because saline groundwater is found at depths of 3,400 feet below sea level (Page, 1973), well below existing wells in the area. The District will review available water quality data on a periodic basis. Should saline intrusion become a problem in the future, a GMP amendment will be prepared to address the issue.

Currently, the District strives to prevent the importation of saline surface waters that

could ultimately degrade the groundwater. When alternative water sources are available for importation, the District considers not only the cost but also the quality, including salinity, of the water. The District will evaluate all possible alternatives, and, when practical and feasible, select water sources with low levels of salinity that will not substantially degrade its soils or groundwater.

Existing Activities

- Review available water quality data to identify areas with the potential for saline water intrusion.
- Import surface waters with low salinity, when feasible and economical.

Planned Actions

- Map and track the progression of any saline water bodies in the District and neighboring lands.
- Monitor depth of new wells with respect to depth to saline connate water.

6.4 - Migration of Contaminated Groundwater

Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Human induced sources of groundwater contamination can include irrigation, confined animal facilities, improper application of agricultural chemicals, septic tanks, industrial sources, stormwater runoff, and disposal sites.

The management and remediation of contaminant plumes generally falls under the responsibility of other agencies such as the Kings County Department of Public Health, California Regional Water Quality Control Board, California Environmental Protection Agency and the U.S. Environmental Protection Agency. The degree to which each agency participates depends on the nature and magnitude of the problem. Since KCWD is not responsible for contaminant plume management it is not aware of the number or extent of plumes in the area, although it is known that there are hydrocarbon plumes in the City of Hanford, which are being remediated. The District will regularly review groundwater quality data from other sources and remain alert to the possibility of contaminated groundwater migration into KCWD.

Existing Activities

- Regularly review data and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.

Planned Actions

- Strategically locate recharge basins with respect to known areas of water quality problems to blend water supplies and/or create a hydraulic barrier to impede movement of contaminant plumes.

- Sample for constituents of concern using dedicated monitoring wells in areas of known contamination.
- Collect and consolidate maps from other agencies identifying the contaminant plumes in the District.
- If necessary, alter groundwater pumping patterns to change the hydraulic gradient and reduce contaminant migration, or reduce the pumping of contaminated groundwater.

6.5 - Groundwater Quality Protection

The District's surface water supplies cannot fully support the crop demand within the District, and therefore some groundwater will always be necessary. The groundwater, however, will have limited or no use if it has poor quality. Therefore, protecting the quality of the groundwater is a cardinal component of this GMP. Groundwater quality can be protected through proper use of pesticides, herbicides and fertilizers, stormwater quality management, septic system management, and water vulnerability planning and management. Some of these tasks are the responsibility of cities and communities, but KCWD will support its efforts whenever possible.

Existing Activities

- Educate growers on the proper use of pesticides, herbicides and fertilizers.
- Import and recharge high quality surface water.

Planned Actions

- Seek funding to improve security at KCWD water facilities (i.e. wells, recharge basins, etc.) and reduce the potential for contamination from acts of vandalism or terrorism.
- Follow State and Kings County well construction standards for wellhead protection to protect groundwater quality.
- Construct, abandon and destroy wells according to State and Kings County standards.

7 - GROUNDWATER SUSTAINABILITY

On average, groundwater comprises about 65% of the water used in KCWD, but can comprise over 80% of water supplies in a drought. During years with low surface water allocations, groundwater is essential to prevent the loss of permanent crops and agricultural businesses. Groundwater is the most dependable water supply for the District's growers and local domestic water users. Therefore, preserving the sustainability of groundwater is essential for the economic well being of the District and its growers.

A decline in groundwater levels would reduce groundwater reserves, increase pumping lifts, and could require deepening or abandonment of wells. Therefore, maintaining these stable groundwater levels is a high priority for KCWD.

7.1 - Issues Impacting Groundwater Sustainability

Issues of concern for groundwater sustainability in KCWD are discussed below:

Drought and Groundwater Level Declines. Depths to groundwater within the District have continued to increase over the last several years, although spring 2010 groundwater level data showed an average of 19 feet of recovery District wide from fall 2009. Conservation and groundwater banking projects are essential to maintain the District's groundwater resources so that they are as reliable as possible during times of drought and reduced surface water availability.

Regional Water Supply Issues. Impacts to other water supplies that KCWD does not normally use can also affect KCWD through increased overall demand and prices for surface water, and increased groundwater pumping in the groundwater basin. Some regional water supply issues include the San Joaquin River Restoration and pumping restrictions in the Sacramento-Bay Delta to protect sensitive species.

Cropping Patterns. In recent years, the District has experienced a significant shift in cropped acreage. Double cropping and triple cropping has become more common, particularly at new dairy sites. This has caused an increase in overall water demands. In addition, permanent planting have become more popular. These increase winter water demands and reduce the ability of growers to fallow land and reduce demand in droughts.

Population Growth. The Central Valley is one of the fastest growing regions in California. Although KCWD provides agricultural water, significant population growth will increase water demands and tensions over water use in the region.

7.2 - Overdraft Mitigation

Groundwater overdraft occurs when well pumping exceeds both natural and artificial groundwater replenishment (recharge, seepage, groundwater inflow, etc.) No recent analyses have been performed, but in 2001 the groundwater overdraft in KCWD was estimated to be about 12,000 AF/yr. However, this analysis included approximately 20,000 AF/year of water purchased through the CVP system, which no longer occurs. Periodic analyses of groundwater overdraft, perhaps every five years, are needed to reassess the need for mitigation of overdraft.

Groundwater overdraft can be mitigated by water conservation efforts, increasing surface water imports, and increasing groundwater recharge. Increasing surface water supply would rely on improving the District's ability to use excess Kings River and Kaweah River flows. Flood water appears adequate on the Kings River to mitigate the overdraft condition if sufficient recharge capacity can be developed. The following groundwater management policies are also followed to help reduce groundwater overdraft:

Limitations on Pumping

The California Water Code gives water and irrigation districts the power to limit or suspend groundwater extractions. These limits can only be implemented if the District determines through study and investigation that groundwater replenishment programs, or other alternative sources of water supply, have proved insufficient or infeasible to lessen impacts to groundwater. KCWD has no intention of limiting groundwater pumping or interfering with private landowner's rights to pump groundwater. If groundwater overdraft becomes severe, the District may pursue a voluntary program for reducing groundwater pumping, which would include incentives to compensate users for reducing their groundwater use.

Limitations on the Exportation of Water Supplies

The District generally does not support groundwater pumping for export out of the District unless it involves a transfer or exchange of water that will not reduce the total water supply available to the District. In addition, the District usually opposes surface water transfers that are accompanied with increased groundwater pumping used to replace the transferred surface water. Exceptions could apply to growers that own land on both the KCWD border and just outside of the border, since they will be using the groundwater in the vicinity of KCWD and in the same groundwater basin. Other groundwater exports will be reviewed on a case-by-case basis and will be permitted if they are approved by the Board of Directors. Under some circumstances, an exchange involving a net loss in water may be considered. This could occur, for instance, if KCWD exchanges poor quality water for good quality water, or if KCWD exchanges floodwater for dry year water.

Economic Inducements

The District recognizes that management of water supplies should reflect water conservation and the protection of groundwater resources. The District currently provides

an indirect economic inducement by establishing water rates high enough to promote water conservation yet low enough to compete with groundwater pumping costs. This pricing system encourages the use of surface water to meet irrigation demands when available, thereby preserving the underlying groundwater resource.

Existing Activities

- Oppose groundwater exports from the District.
- Set surface water rates low enough to be comparable to groundwater pumping costs.

Planned Actions

- Periodically, such as every 5 years, perform a hydrologic balance to estimate the amount of groundwater overdraft, if any.
- Evaluate annual groundwater contour maps for evidence of pumping well interference from neighboring agencies.
- Estimate amount of groundwater flowing out of District, mainly to the south and west.
- Educate growers on water conservation and conditions of overdraft.
- Increase capacity to recharge excess floodwater.
- Develop new sources of surface water for recharge and conjunctive use.

7.3 - Groundwater Replenishment

Replenishment of groundwater underlying the District occurs both naturally and through deliberate, controlled means (artificial). The various forms of groundwater replenishment in KCWD are listed below:

- Groundwater inflow to the District
- Deep percolation from precipitation
- Artificial recharge
- Groundwater banking
- In-lieu deliveries
- Streambed infiltration
- Deep percolation from irrigation
- Seepage from distribution facilities

Quantities are not available for most of these hydrologic variables, and as a result, there is no updated and comprehensive water balance or estimate of safe yield for the District. The quantities of groundwater recharge and in-lieu deliveries are however known with relative accuracy and are discussed below.

Groundwater Recharge. There are about 25 recharge basins within District boundaries and water is recharged via unlined canals throughout the District. The total area of the recharge basins and unlined ponds is estimated to be 1,300 acres.

In-lieu deliveries. KCWD deliveries considerable quantities of surface waters to its growers reducing the volume of groundwater pumped, thus resulting in in-lieu groundwater recharge.

Existing Activities

- Groundwater recharge in 25 existing recharge basins.
- Measure the volume of water delivered to groundwater recharge basins.
- Periodically remove sediment and rip the soils in recharge basins to maintain recharge rates.
- Maintain existing unlined canals in an unlined or open bottomed condition in those locations where it is determined that canal seepage is a significant source of recharge and does not create detrimental side effects.
- Evaluate potential arrangements and projects with existing and potential partners to cooperatively improve groundwater recharge within the District.
- Apply for grants or participate in grant applications with partners to improve the operation of groundwater recharge basins or the development of new basins.
- The District has active programs to fallow land and recharge water during flood periods.

Planned Actions

- Perform a detailed water balance for the entire District, and prepare a user-friendly water balance model that can be used to estimate parameter values on a yearly basis.
- Procure lands for more groundwater recharge basins when property is available and is affordable to the District at market value.
- Perform studies, subsurface exploration, and infiltration tests to determine areas suitable for recharge.
- Determine the area benefitting from recharge in each basin to aid in selecting areas for constructing new basins.
- Finish the development of the Garner Basin, a 36.5-acre borrow pit, into a recharge and regulation basin, in collaboration with Lakeside Ditch Company and KDWCD.
- Implement a water exchange program where a water agency would sell normal year water to KCWD to bank and purchase a portion of that water at a higher price in dry years.
- Investigate the feasibility of constructing additional recharge basin and banking facilities so that more surface waters can be imported and used in the District.
- Monitor the rates of recharge in basins, natural channels and ditches, and, when feasible use the facility that offers the greatest recharge rate in order to maximize recharge potential.

- Develop and maintain an inventory of sites in the District that are suitable for recharge.
- Work cooperatively to minimize development on lands that are favorable for artificial recharge.
- Where unknown, determine the recharge rate in each basin by monitoring inflows, outflows and water levels.

7.4 - Conjunctive Use of Water Resources

Conjunctive operation of a groundwater basin is defined in DWR Bulletin 118-80 as:

> "Operation of a groundwater basin in coordination with a surface water reservoir system. The basin is intentionally recharged in years of above average precipitation so groundwater can be extracted in years of below average precipitation when surface water supplies are below normal."

Such management results in groundwater storage being reduced in dry periods and increased in wetter periods. To avoid a condition of overdraft, replenishment must balance or exceed extraction over the long-term.

A conjunctive use program requires the following:

1. A source of surface water in years of high surface water supply.
2. Recharge facilities capable of recharging excess surface water.
3. Conveyance facilities to import and export water to and from the groundwater storage area.
4. Available storage capacity in the aquifer.
5. Recovery facilities.
6. Distribution facilities for surface and groundwater.

Kings County Water District currently has facilities in place to operate a conjunctive use program, and in fact, has been operating in such a manner for some time. Additional measures proposed in this plan are hoped to provide a greater capacity for using excess Kings River flows, and hopefully a long-term groundwater balance can be obtained.

The District's conjunctive use program includes surface water delivery in lieu of groundwater pumping, groundwater recharge and banking, and, when practical, transfers to neighboring areas sharing a common groundwater supply. These are discussed below:

Surface Water Deliveries. The District provides surface water to several local ditch, mutual water and canal companies. These entities own and operate, with the exception

of the Riverside Ditch, the delivery facilities within the District; delivering District surface and groundwater water supplies to the growers. The surface water is a form of in-lieu groundwater recharge, since it reduces the volume of groundwater pumped. KCWD strives to keep surface water rates low enough that growers choose to fully utilize surface water supplies before resorting to groundwater.

Purchase Ditch Company Stock. The private ditch companies in the area allocate water according to stock ownership. The District has purchased ditch company stock in the past to prevent the stock owners from using the water outside of the district boundaries. The District also has financial reserves for purchasing additional stock if it becomes available for sale.

Groundwater Recharge and Banking. KCWD performs direct groundwater recharge in 25 recharge basins, and through seepage in earthen canals that are left unlined because of their recharge benefit. District staff estimates that the recharge basins plus the unlined canals cover approximately 1,300 acres. The amount of recharge varies each year with the availability of water. Having significant recharge capacity is important so that large volumes of water can be captured in wet years to recharge and later use in dry years. KCWD desires to construct more recharge and banking facilities in the near future. Groundwater recharge has been performed largely with Kings River floodwater. KCWD has attempted to use as much floodwater as possible to help recharge the groundwater, and store groundwater for later use.

Water Transfers to Agencies within the Same Groundwater Basin. Sometimes the District has supplies in excess of agricultural demand and available storage behind local reservoirs. With these water supplies KCWD regularly performs water transfers and exchanges with other water agencies. KCWD strives to keep any exported or excess water in its region so it benefits the local groundwater supply and groundwater migration out of the District. KCWD also selects local exchange partners because it can benefit the local economy. The priority of water transfer partners include: 1) neighboring agencies; 2) Agencies in the same groundwater sub-basin, 3) Agencies in the southern Central Valley; and 4) Agencies in the Central Valley.

Existing Activities

- Support and facilitate the delivery of imported water supplies to neighboring agencies for the purposes of reducing groundwater migration out of the District.
- Work with all appropriate public agencies, private organizations, and individuals within and outside of the plan area to protect existing surface water rights and supplies.
- Participation in KDWCD water supply and board of directors meetings and Kaweah and St. Johns Rivers Association meetings to facilitate the cooperative operation and efficient use of available resources on the Kaweah and St. Johns Rivers system.
- Continue to recharge surface waters in existing facilities.

Planned Actions

- Support the development of new surface storage and water supply projects that would permit the participants to better utilize surface water supplies.
- Expand existing recharge and banking facilities to allow the District to import more surface water.
- Renew discussions with the City of Hanford on conjunctive use projects that would benefit both parties.

7.5 - Water Conservation and Education

The District considers water conservation and education important aspects of its overall groundwater management efforts. The District participated in several water conservation and education programs including the Kings County Water Education Committee, Education and Agriculture Together Foundation, California Farm Water Coalition, Association of California Water Agencies, and Water Education Foundation. The District contributes funds and staff time to these agencies.

Water conservation is considered important in KCWD, however, most District growers use water in a responsible and efficient manner. Many of the District's growers conserve water through the use of highly efficient drip, micro-jet, and micro-sprinkler irrigation system technology. In addition, all water deliveries are metered and billed based on the volume used. Therefore, all customers have an incentive to minimize water usage. Despite all these water conservation achievements, KCWD still provides on-going water conservation education to its growers.

Existing Activities

- Monthly water statements include water use information for each customer. In addition, the District maintains historic water use by turnout. This data is available to water users on request as it could be beneficial in making on-farm water management decisions.
- The District participates in the KDWCD WRI Study and its updates to analyze the region's water balance and document changing conditions over time.
- KCWD frequently write articles on water issues for the local newspaper, the Hanford Sentinel.
- Participation in several water conservation/education organizations.

Planned Actions
None

7.6 - Water Recycling

The City of Hanford and Community of Armona are the major municipalities in KCWD. Both generate effluent from their wastewater treatment plants. Hanford sends about 75% of its effluent to Lakeside Water Irrigation District (which is located entirely within

KCWD) for irrigation. A small amount is also delivered to growers neighboring the treatment plant, and the remainder is percolated. The City of Armona percolates its effluent in ponds. The KCWD does not directly use recycled water from Hanford, Armona or other municipalities. However, the water is either percolated to the groundwater, or used by growers within KCWD.

Existing Activities

None

Planned Actions

- Remain cognizant of opportunities to purchase recycled water from other local industrial facilities and municipalities.

8 - GROUNDWATER OPERATIONS

8.1 - Well Construction Policies

Kings County Water District does not have its own well construction policies, but rather follows State and County standards.

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. Department of Water Resources Bulletins 74-81 and 74-90 provide useful guidelines for the construction of groundwater wells. Proper wellhead protection is essential to ensure that contaminants do not inadvertently enter a well. Well construction policies that are intended to ensure proper wellhead protection are discussed in Section 6.2 – Wellhead Protection.

Kings County has adopted a well ordinance that specifies water well construction, deepening, and reconstruction standards within its jurisdiction. In the ordinance, reference is made to State of California, Department of Water Resources Bulletins 74-81 and 74-90. The ordinance has provisions that require permits for well construction, deepening and reconstruction, with oversight provided by the County's health or building departments.

In addition, the District will follow the quality assurance procedures below when contracting for the construction of new District wells. Landowners are also encouraged to follow these procedures when constructing private wells:

1. Well construction will be performed under contract by a licensed and experienced well driller, in accordance with specifications prepared by a licensed engineer or geologist, and reviewed by legal counsel.
2. A licensed engineer or geologist will oversee construction of the wells.
3. A licensed land surveyor in the State of California will oversee survey of any newly constructed wells.

Existing Activities

- Construct wells according to DWR Bulletin 74-81 and 74-90, and Kings County standards.

Planned Actions

- Educate landowners on the existing Kings County well ordinance and State guidelines.
- Construct wells using qualified and licensed contractors, engineers, geologists and land surveyors.

8.2 - Operation of Facilities

Effectively managing a groundwater supply requires facilities that protect the quality and assure that the quantity of groundwater in storage is sufficient to meet long-term

operational goals. Kings County Water District currently has facilities in place to meet these management requirements. Groundwater facilities in KCWD include recovery wells, monitoring wells, and recharge basins. The operation of each of these is discussed below.

Recovery Wells. KCWD owns and operates 5 recovery wells, all used to recover banked water from the Apex Ranch Conjunctive Use project.

Monitoring Wells. KCWD owns 4 dedicated monitoring wells, which are all located at the Apex Ranch Conjunctive Use project. In addition, the District monitors 40 to 45 local private wells as part of an expanded monitoring network for the project. KCWD also uses up to 280 private wells to monitor groundwater level throughout the District and in neighboring Districts near the KCWD border.

Recharge Basins. KCWD owns and/or operates about 25 recharge basins. The largest is the Apex Ranch Conjunctive Use project, which recharges water along 50 acres of abandoned River Channel.

Distribution System. The District distributes surface water and groundwater pumped from the Apex Ranch Conjunctive Use Project through the Riverside Canal. Numerous other canals are found in the District, but they are owned and operated by several private ditch companies.

Existing Activities

- Maintenance of recharge facilities including de-vegetation, disking, deep ripping, and de-silting, as necessary to improve recharge potential.
- Leave earth canals unlined so they can be used for groundwater recharge.

Planned Actions

- When practical and beneficial, develop groundwater recharge facilities as multi-functional facilities that also serve other purposes such as urban stormwater runoff, environmental enhancement, aesthetics, and groundwater banking.
- Investigate partnerships with local wildlife groups to see if common goals can be pursued through shared resources in efforts to develop additional recharge areas.

9 - GROUNDWATER PLANNING AND MANAGEMENT

9.1 - Land Use Planning

The intent of this Plan is not to dictate land-use planning policies, but rather to establish some land-use planning goals that can aid in protecting and preserving groundwater resources. KCWD does not have direct land-use planning authority. However, KCWD does have the opportunity to comment on environmental documents for land-use related activities and proposed developments as well as proposed Kings County General Plans and updates.

Land use planning activities in unincorporated areas of Kings County are performed by the County's Department of Public Works planning division, and overseen by the Kings County Planning Commission and the Board of Supervisors. Responsibility for land use planning in incorporated areas lies with each community's planning staff. The City of Hanford's staff, planning commission and City Council are responsible for land use planning within the City's Sphere of Influence.

KCWD will attempt to work cooperatively with other agencies to minimize adverse impacts to groundwater supplies and quality as a result of proposed land-use changes. Some specific land-use planning goals include: (1) preserving areas with high groundwater recharge potential for recharge activities; (2) protecting areas sensitive to groundwater contamination; (3) requiring hydrogeologic investigations, water master plans, and proven and sustainable water supplies for all new developments; and (4) requiring appropriate mitigation for any adverse impacts that land use changes have on groundwater resources.

Existing Activities

- Notify residents and agencies of projects that have the potential to impact groundwater within its sphere of influence.
- When appropriate, comment on environmental documents and land-use plans that have the potential to impact groundwater.
- Provide input on City of Hanford and Kings County planning efforts, particularly on issues that impact groundwater resources.
- Stay informed of changes to the City of Hanford's Sphere of Influence, annexations and de-annexations.

Planned Actions

Remain cognizant of opportunities to purchase land in areas favorable for recharge.

9.2 - Numerical Groundwater Model

In 2005, utilizing a cooperative grant from the State Department of Water Resources, the KDWCD developed a groundwater model to calculate future changes in groundwater conditions from changes in population growth, water supply and

distribution. The model is able to calculate quantifiable changes to groundwater levels and flow conditions. This analytical tool can be applied to assess how existing and proposed groundwater management actions, changes in cultural practices, or changes in hydrologic conditions may influence groundwater sustainability. The knowledge gained from the model will be applied in the development and evaluation of new and existing programs.

A portion of KCWD is within the borders of KDWCD (see Figure 2). Hence, the model provides useful information on hydrologic parameters in the eastern part of KCWD, as well as regional information on the hydrology and geology to the east of KCWD. The model, however, does not provide a water balance for the entire KCWD.

Existing Activities

- Remain abreast of the uses of the groundwater model by local partners for planning purposes, and KDWCD's efforts to periodically update the model and its analysis of the regions groundwater.

Planned Actions

- When appropriate, use the KDWCD numerical groundwater model to evaluate proposed projects and changes to current groundwater operations, and determine their net impact on groundwater conditions.
- Seek funding to develop a numerical groundwater model specific to the KCWD.

9.3 - Groundwater Reports

The District has a goal to prepare groundwater reports every year to document groundwater levels, available groundwater storage, historical trends, and other important groundwater related topics. This information will be used to forecast future problems, plan future groundwater projects, and develop new groundwater policies. The annual report will cover the prior calendar year and will be completed each year by April 30th. Currently the District prepares semi-annual District wide groundwater contour maps and an Annual Report of Operations for the Apex Ranch Conjunctive Use project. Taken together these are considered equivalent to an annual groundwater report. More detail on the Apex Ranch annual reports is provided below.

Apex Ranch Annual Reports

Each year the KCWD prepares an annual monitoring report for the Apex Ranch Conjunctive Use Project. The report covers a given water year from October 1 to September 30. The main sections in the monitoring reports include the following:

- Program Objectives
- Monitoring Committee
- Groundwater Monitoring Program
- Construction Activities

- Recharge Operations
- Recovery Operations
- Water Level Monitoring
- Water Quality Monitoring

Hydrographs are created for select monitoring wells that have data loggers, and groundwater surface profiles are created along the groundwater recharge channel. The monitoring data is evaluated to determine the change in groundwater storage, direction of groundwater flow, and possible impacts to neighboring wells.

Existing Activities

- Preparation of groundwater contour maps (elevation and depth to water) and estimated changes in groundwater storage each spring and fall
- Preparation of annual monitoring reports for the Apex Ranch Conjunctive Use Project

Planned Actions
None

9.4 - Plan Implementation

Of all the GMP elements, the most critical actions are those that lead to stabilization of groundwater levels. This can be achieved through groundwater recharge, groundwater banking, water conservation, and importing additional surface water supplies. These actions are the centerpiece of the District's groundwater management implementation plan.

Implementation of this updated GMP is also expected to result in significant amounts of new knowledge and an achievable improvement in groundwater management in KCWD. Figure 15 includes an implementation schedule for this GMP from 2011-2015. The schedule does not include existing activities that will be continued. KCWD will maintain all existing programs unless stated otherwise in this GMP. Rather, the schedule includes new tasks and projects that are considered a high priority for the District.

9.5 - Plan Re-evaluation

The Groundwater Advisory Committee will be responsible for monitoring the progress in implementing the GMP objectives. Refer to Section 4.1 for more information on the membership, policies, and procedures of the Committee. The Committee will attempt to meet monthly to review and evaluate groundwater conditions as well as evaluate the effectiveness of the GMP. As new policies, practices, and ordinances become necessary or desirable to enhance the management of the District's groundwater supply, this Plan will be amended as necessary.

Existing Activities

None

Planned Actions

- Update the GMP at least every five years through a formal public process, or more frequently if a sufficient quantity of revisions, updates and additions have been identified.
- Evaluate the effectiveness of the GMP and need for an update at least once a year.
- Document recommendations for improving or updating the GMP in each annual Groundwater Report.

9.6 - Dispute Resolution

Groundwater disputes in KCWD can fall into three general categories: 1) Landowner versus Landowner; 2) KCWD versus Landowner; and 3) KCWD versus another agency.

Landowner versus Landowner

Disputes between landowners are not the responsibility of KCWD, however, when asked to, KCWD may choose to help resolve disputes as an impartial mediator. Such efforts are intended to maintain amicable relationships among landowners, educate landowners on groundwater management goals and policies, and avoid adjudicating the local groundwater basin.

KCWD versus Landowner

Disputes with landowners are generally resolved through the District Manager. If necessary the dispute will be forwarded to the Board of Directors. KCWD has a formal procedure to resolve disputes on groundwater pumping impacts from District owned wells. If a landowner believes its well is being impacted (lower well yield or lower groundwater levels) they can file a complaint with the District. The following procedure is used to evaluate complaints:

1) Preliminary Hydrogeologic Evaluation. This includes a preliminary analysis to determine if the complaint has potential merit. Typically the distance of the landowner well from the KCWD well is compared to the well's sphere of influence. If the well falls outside of the sphere of influence then it is considered as not being impacted.
2) Gather Information on Well. If the complaint may have merit, then information will be gathered on the well from well construction records, geologic logs, interviews with well owners, inspection of pumping equipment, and, if needed, a well video survey.
3) Identify Cause of Problem. The cause of the problem will be identified through an analysis of data collected. The cause could fall under four general categories: 1) impacted by KCWD well pumping; 2) Impacted by neighboring well owner pumping; 3) regional groundwater level decline; and 4) Insufficient or outdated equipment.

4) Implement Well Improvement Options. If KCWD agrees that they are responsible for the impacts the District will offer to mitigate the problem, typically by lowering pump bowls or installing a higher capacity pump. If KCWD determines that the impacts are caused by the landowner well characteristics, such as an old or low power pump, they will make recommendations for the landowner to implement.
5) Construct Surface Water Facilities. If landowners are being impacted by KCWD wells, and they have no ability to use surface water, KCWD may offer to partially fund construction of a surface water turnout on its property.

Several local landowners formed the Kings River Area Property Owners group in 2008 due to concerns over District well pumping at Apex Ranch. KCWD has provided monitoring data to KRAPO and agreed to revise their groundwater monitoring program. KRAPO landowners have submitted several claims to KCWD maintaining that their wells have been adversely impacted by the project. KCWD has reviewed all of the claims and agreed to fund mitigation measures for some of the landowners. KCWD continues to work with KRAPO and hopes to find consensus on the best way to manage and operate the Apex Ranch Conjunctive Use Project in 2011.

KCWD versus Another Agency

When KCWD faces a dispute with another agency the dispute will be resolved through the KCWD Board of Directors. If necessary, the District Manager may also use legal counsel, technical staff, or technical consultants to assist in addressing any disputes.

KCWD partially overlaps Consolidated Irrigation District and Alta Irrigation District, and completely encompasses Lakeside Irrigation Water District. To date there have been no groundwater disputes between these agencies and they have amicable and cooperative relationships.

If a dispute arises between KCWD another KDWCD agency, then it will be handled according to the Alternative Dispute Resolution Policy provided in the KDWCD GMP. The policy provides procedures for resolving conflicts and favors mediation over litigation. KCWD also has an MOU (dated March 19, 2002) with KDWCD to cooperate on its overlapping Groundwater Management Plans. The KRWA also has policies for settling disputes among its member agencies.

Existing Activities

- Resolve disputes through the District's general dispute resolution procedures.

Planned Actions

- Discuss issues of concern at the annual GAC meetings in an effort to prevent future disputes.

9.7 - Program Funding and Fees

Several alternatives are available to KCWD for funding groundwater projects, and are described below:

Water Replenishment Fees

Under AB3030, local agencies have the authority to limit groundwater extractions and implement water replenishment fees based upon the amount of water extracted (extraction based fees must first be approved by majority vote of impacted landowners). Inherent in these powers is the authority to implement metering of private wells. These are considered measures of last resort and KCWD will strive to ensure the private, non-metered use of groundwater by the local growers. However, if at some point the State begins to regulate groundwater extractions, or if a legal adjudication of the basin occurs, then these fees may be unavoidable.

Capital Improvement Fees

The District has the authority to finance capital improvement projects and collect repayment charges from the benefited parties. This process would require a favorable vote from the constituency, and is considered a realistic alternative for large capital projects, such as groundwater recharge or banking projects.

Grants and Loans

The District will pursue available grants and low-interest loans from the Department of Water Resources as well as other State and Federal agencies like the Bureau of Reclamation. The District realizes that funding from State and Federal agencies for groundwater projects will be partially based on its progress in implementing this GMP.

Other Revenue Sources

Groundwater projects can also be financed through water user fees and assessments that are collected regularly from all district landowners. Historically, the policy of the District has been, and is presently, not to impose water user fees or assessments.

Lease banking facilities

KCWD has explored the option of leasing its groundwater banking facilities to other water agencies. Leasing agreements would require fees to cover operation and maintenance costs, as well as some revenue for KCWD. The agreements would also require that some water be left behind as a net benefit to the aquifer.

Exiting Activities

- Regularly research grant and loan opportunities from the State and Federal governments and apply for these opportunities when they appear advantageous to the District.

Planned Actions

- Identify beneficial groundwater projects that become economically feasible when costs are shared among two or more participants.
- Share information on funding opportunities with other agencies that may be potential partners in multi-agency groundwater projects.

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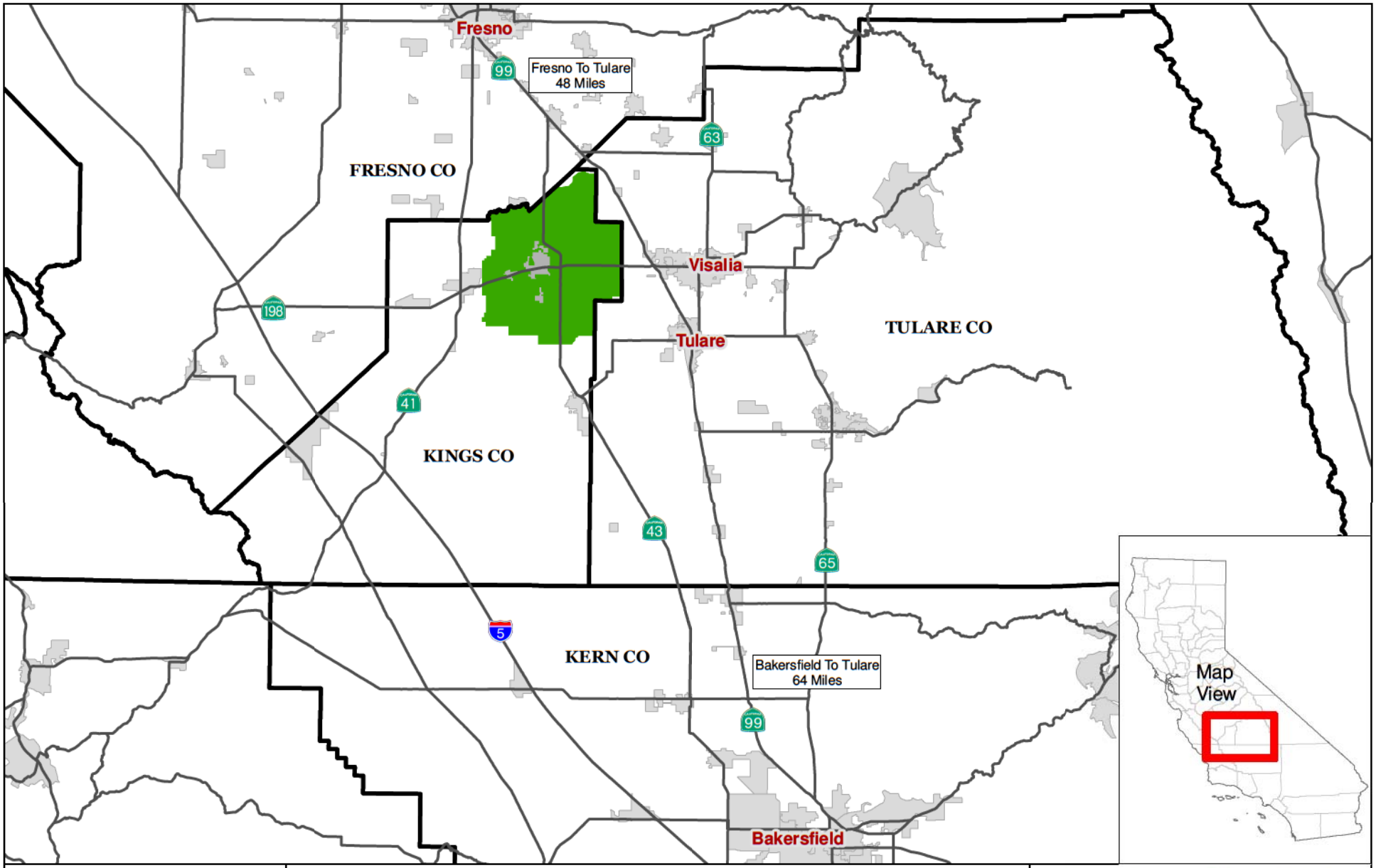
KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

FIGURES



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An Employee Owned Company
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Kings County WD

Kings County Water District

Figure 1

Vicinity Map

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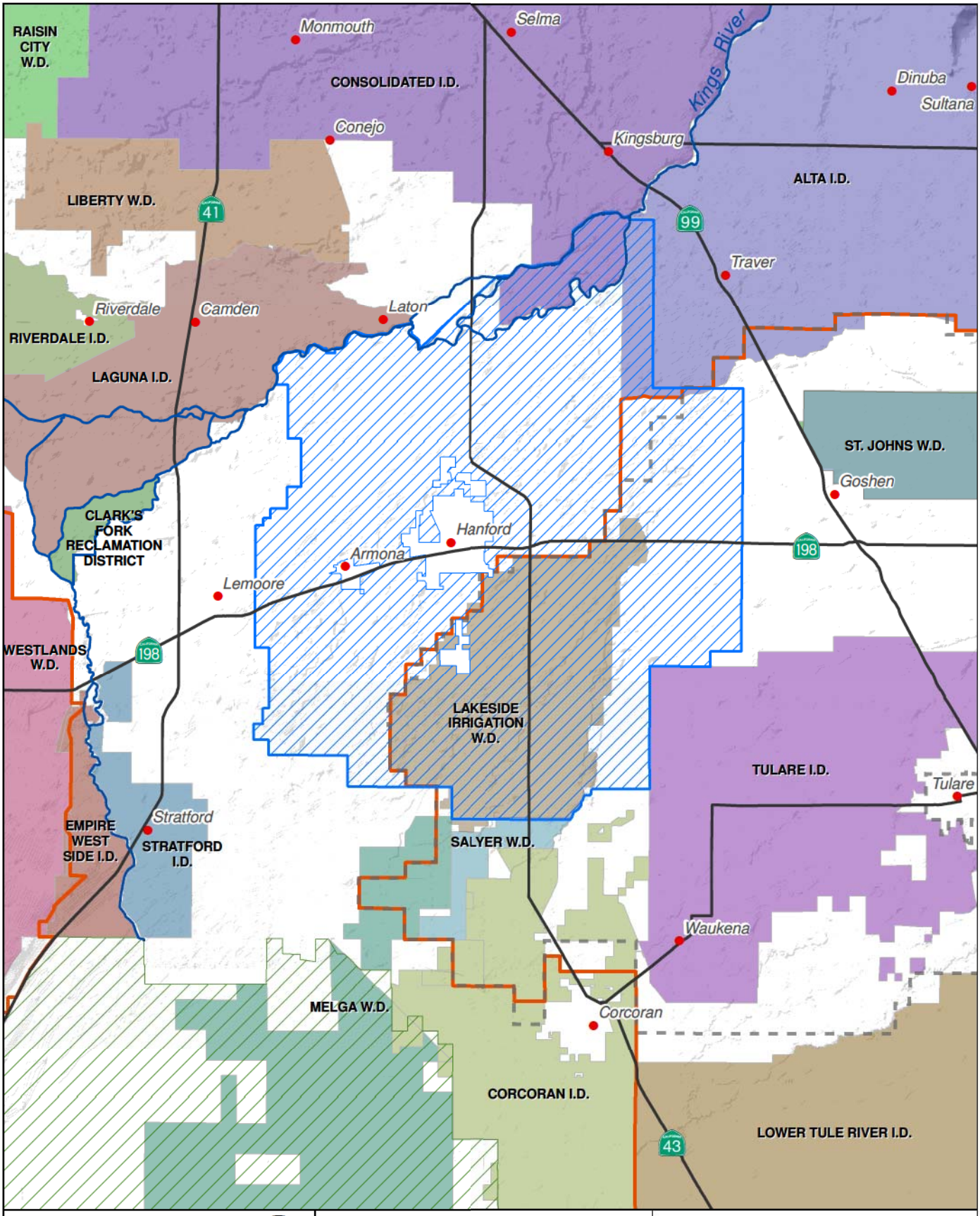

Kings County Water District

Figure 2

Neighboring Agricultural Water Districts

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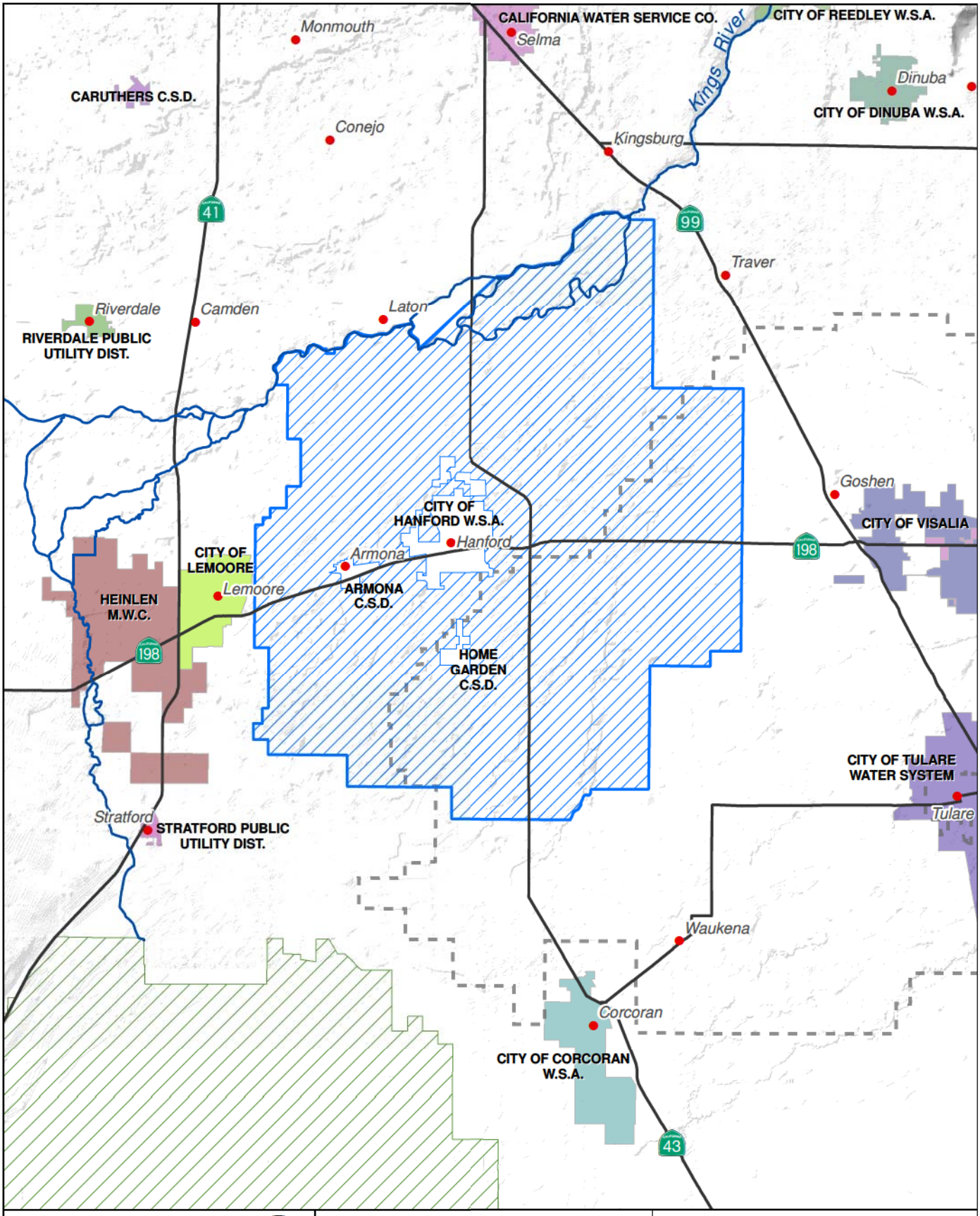
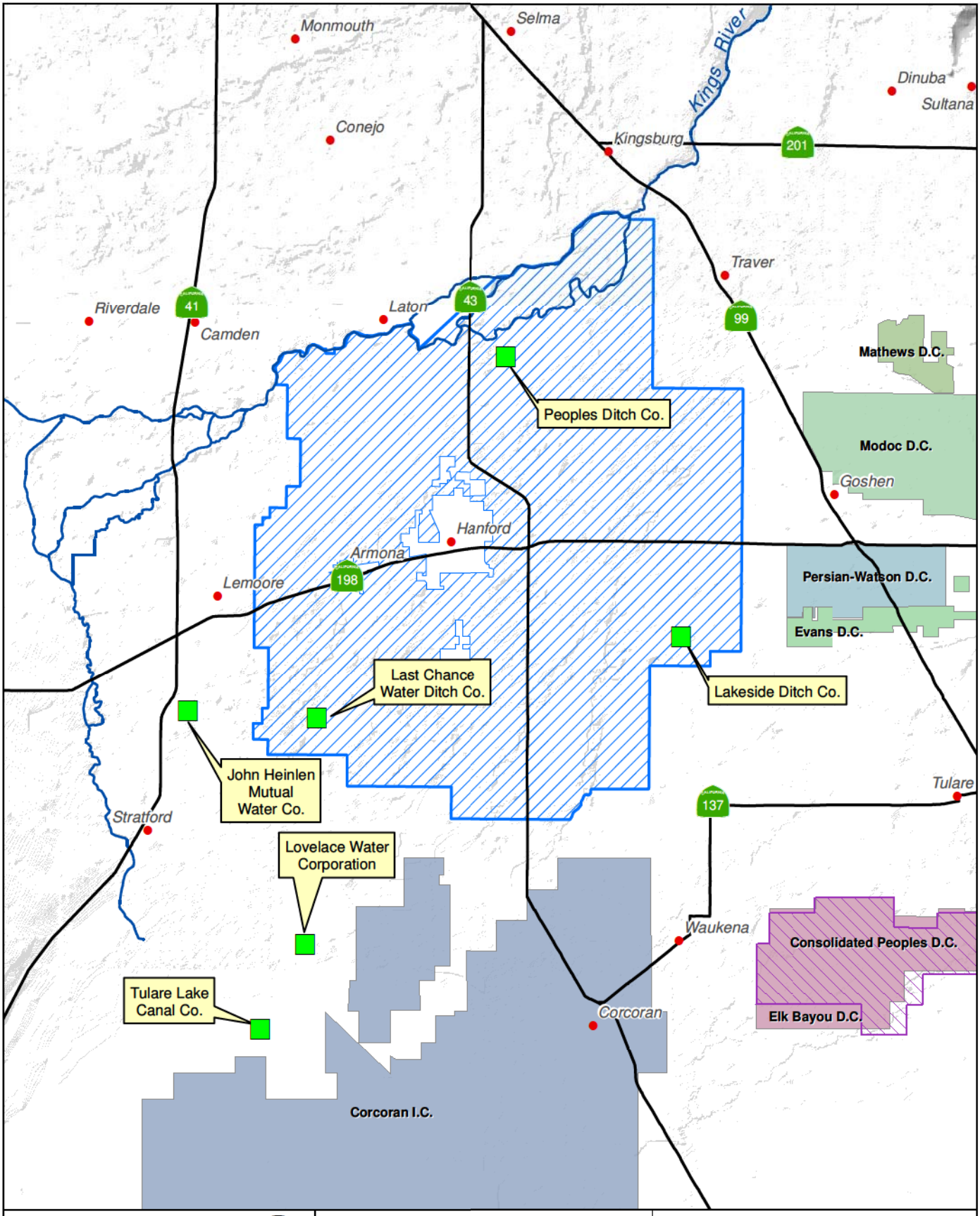
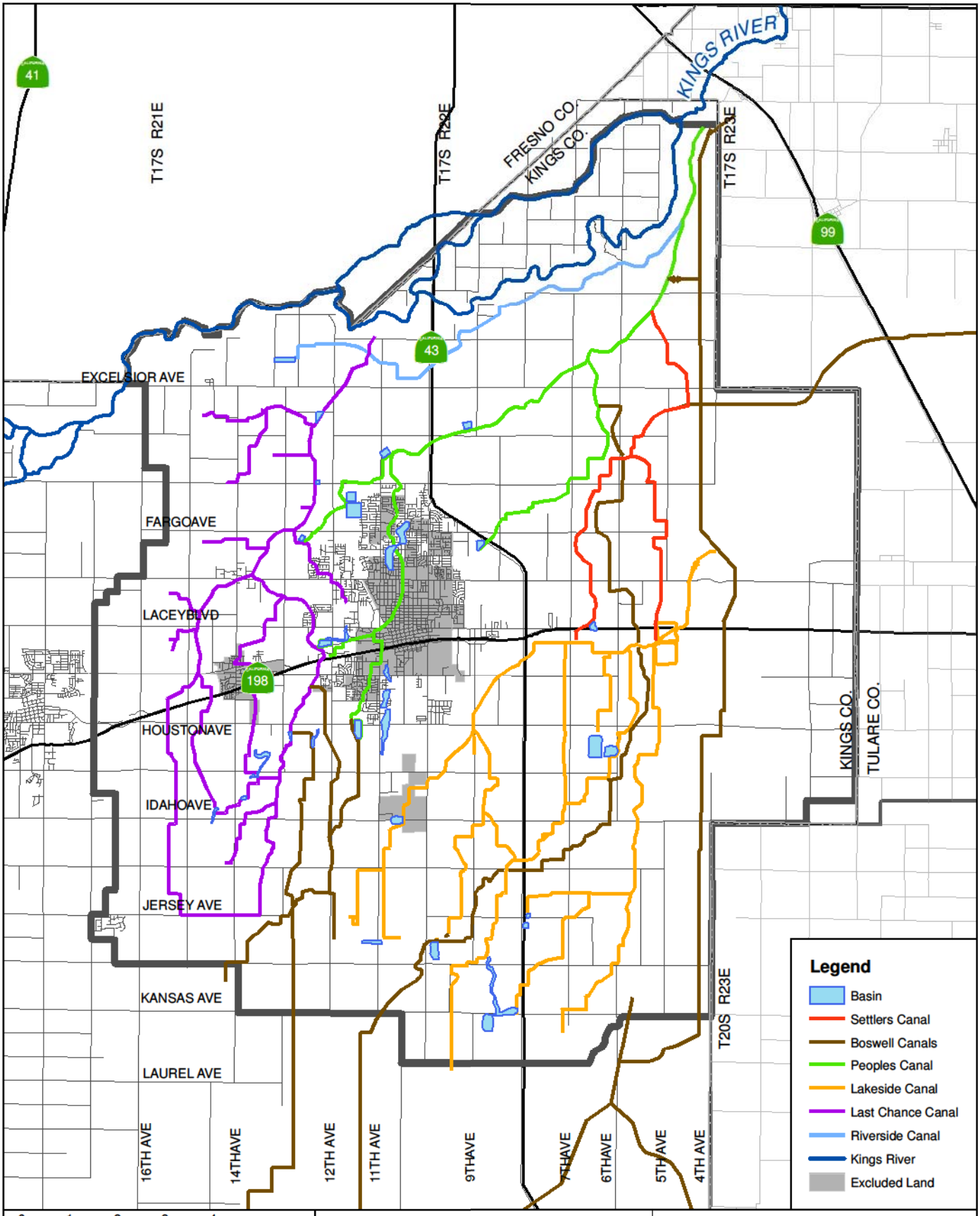
11/29/2010 \\Evolution\clv_clients\Clients\Kings County WD - 2192\PROJECTS\219208C1 - Groundwater Management Plan\GIS\Map\2010 Updated Figs\Fig2_WaterAgencies.mxd



11/9/2010 \\evolution\clv_clients\Clients\Kings County WD - 2192\PROJECTS\219208C1 - Groundwater Management Plan\GIS\Map\2010 Updated Figs\Fig3_WaterAgenciesMunicipal.mxd



2/24/2011 \\Evolution\clv_clients\Clients\Kings County WD - 2192\PROJECTS\219208C1 - Groundwater Management Plan\GIS\Map\2010 Updated Figs\Fig4_DitchandCanalCo.mxd



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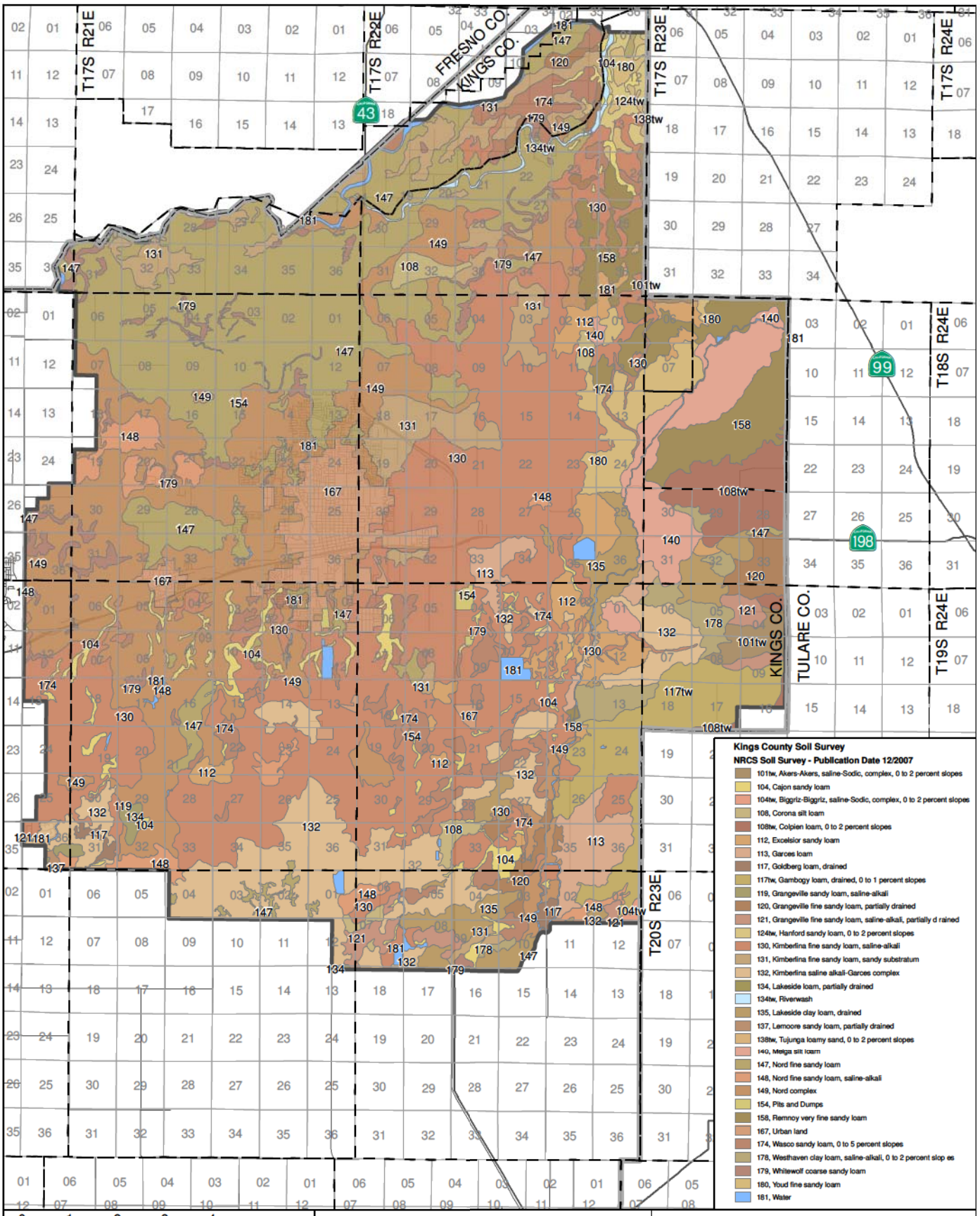
Kings County Water District

Figure 5

Distribution Facilities



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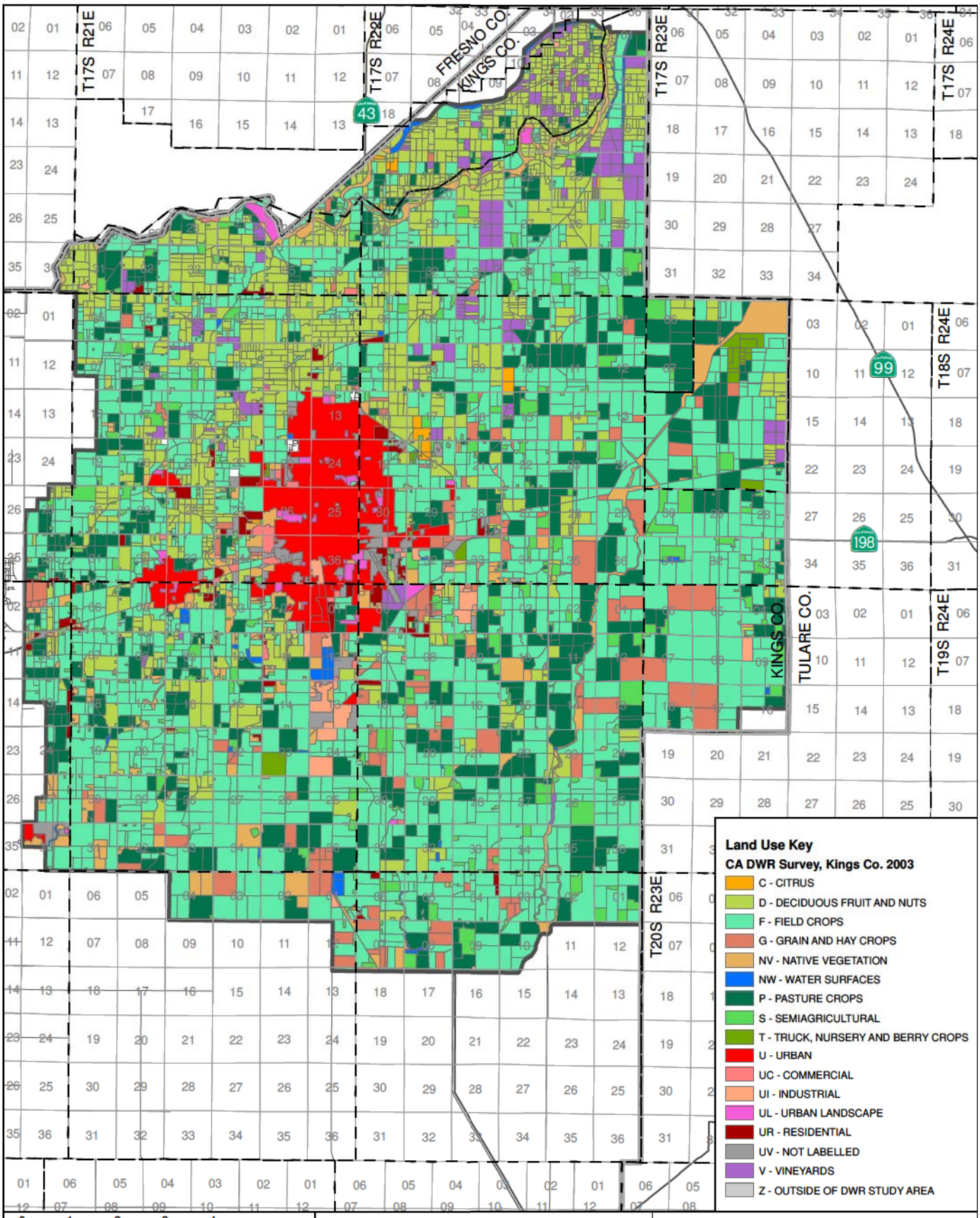
Kings County Water District

Figure 6

Soils



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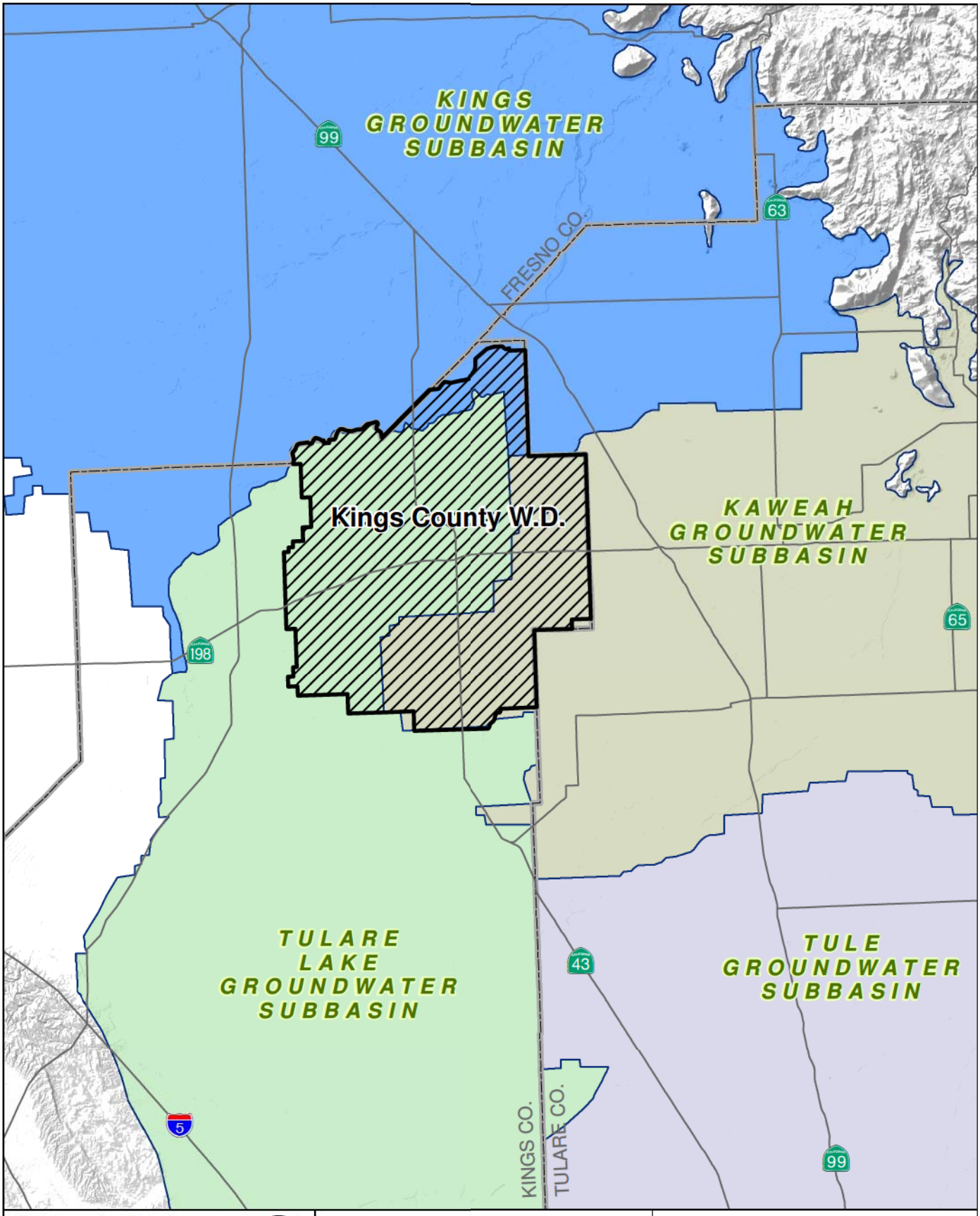
Kings County Water District

Figure 7

Land Use



0 2 4 6 8 Miles

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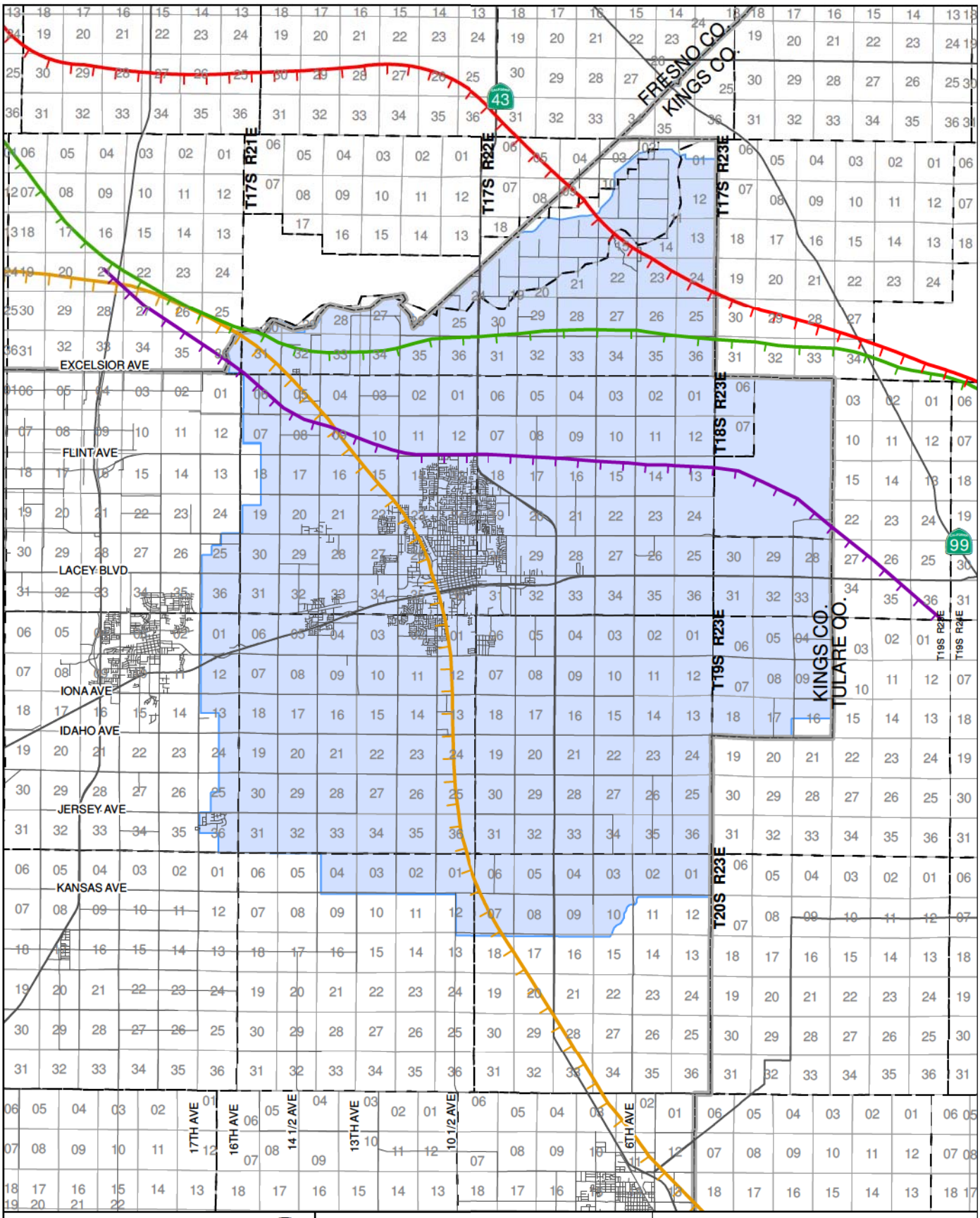
(559) 326-1100

Groundwater Sub Basin
DWR 118-80 (GIS Oct 2000)
- KAWEAH
- KINGS
- TULARE LAKE
- TULE

Kings County Water District

Figure 8

Groundwater Sub Basins



0 1 2 3 4 Miles

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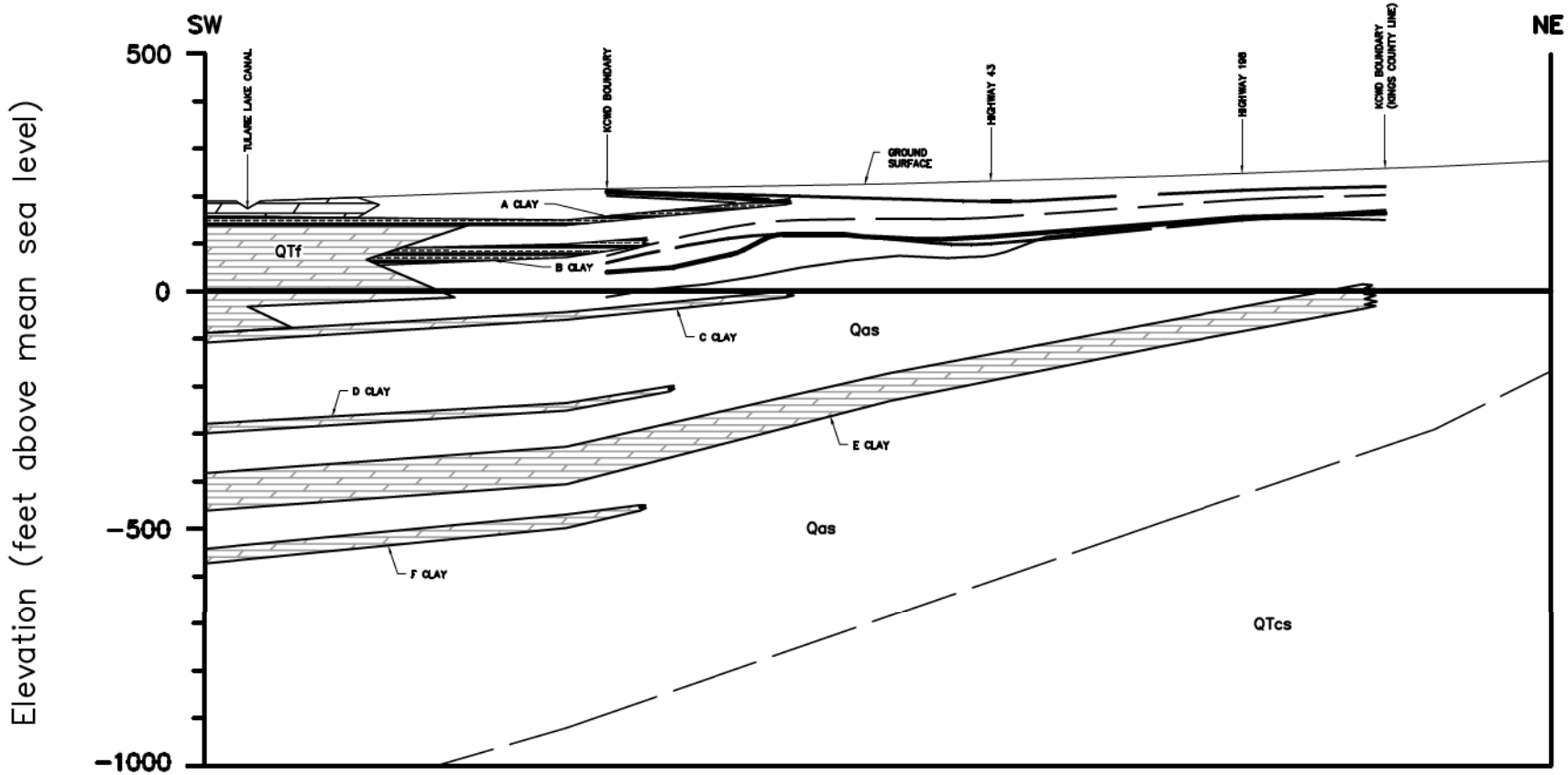
Legend

- A Clay Extent - Croft, 1972
- E Clay Extent - Page, 1986
- E Clay Extent - Croft, 1972
- E Clay Extent - Davis et al, 1957

Kings County Water District

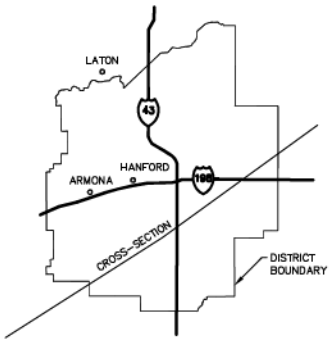
Figure 9

Location of A & E Clay



LEGEND

Qas – QUATERNARY ALLUVIUM – SIERRA NEVADA ORIGIN
Qtf – TERTIARY AND QUATERNARY FLOOD BASIN, LACUSTRINE AND MARSH DEPOSITS
Qtas – TERTIARY AND QUATERNARY CONTINENTAL DEPOSITS



WATER SURFACE ELEVATIONS

1963 – SPRING
1970 – FALL
1994 – SPRING
1994 – FALL
1995 – SPRING

REF: U.S.G.S. WATER SUPPLY PAPER 1999–H (1959)

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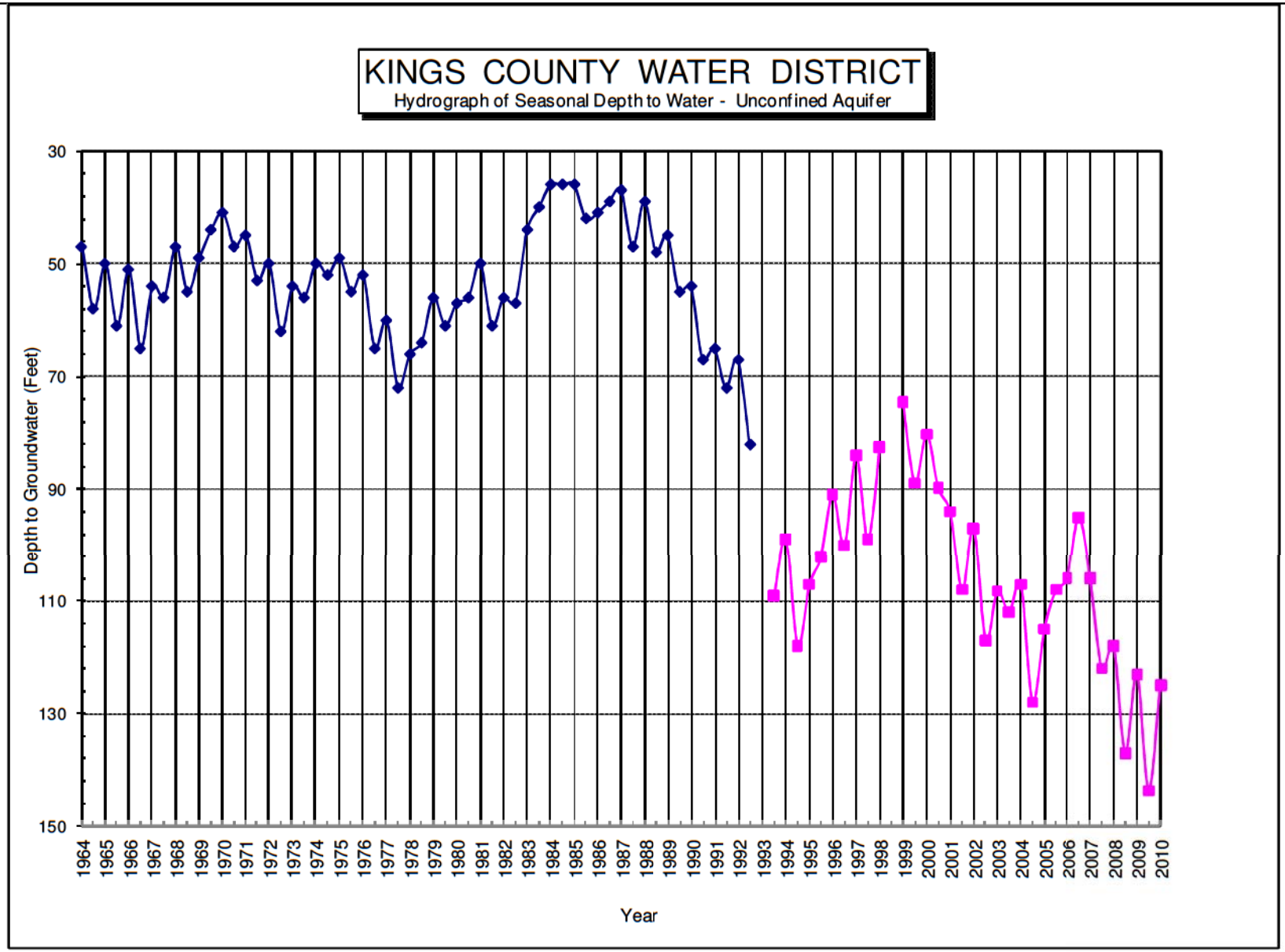
FIGURE 10

KINGS COUNTY WATER DISTRICT

GENERALIZED GEOLOGIC CROSS SECTION

DESIGN ENGINEER: OEK
DATE: 11/10/2010
JOB NO: 219310C1
SHEET 1 OF 1



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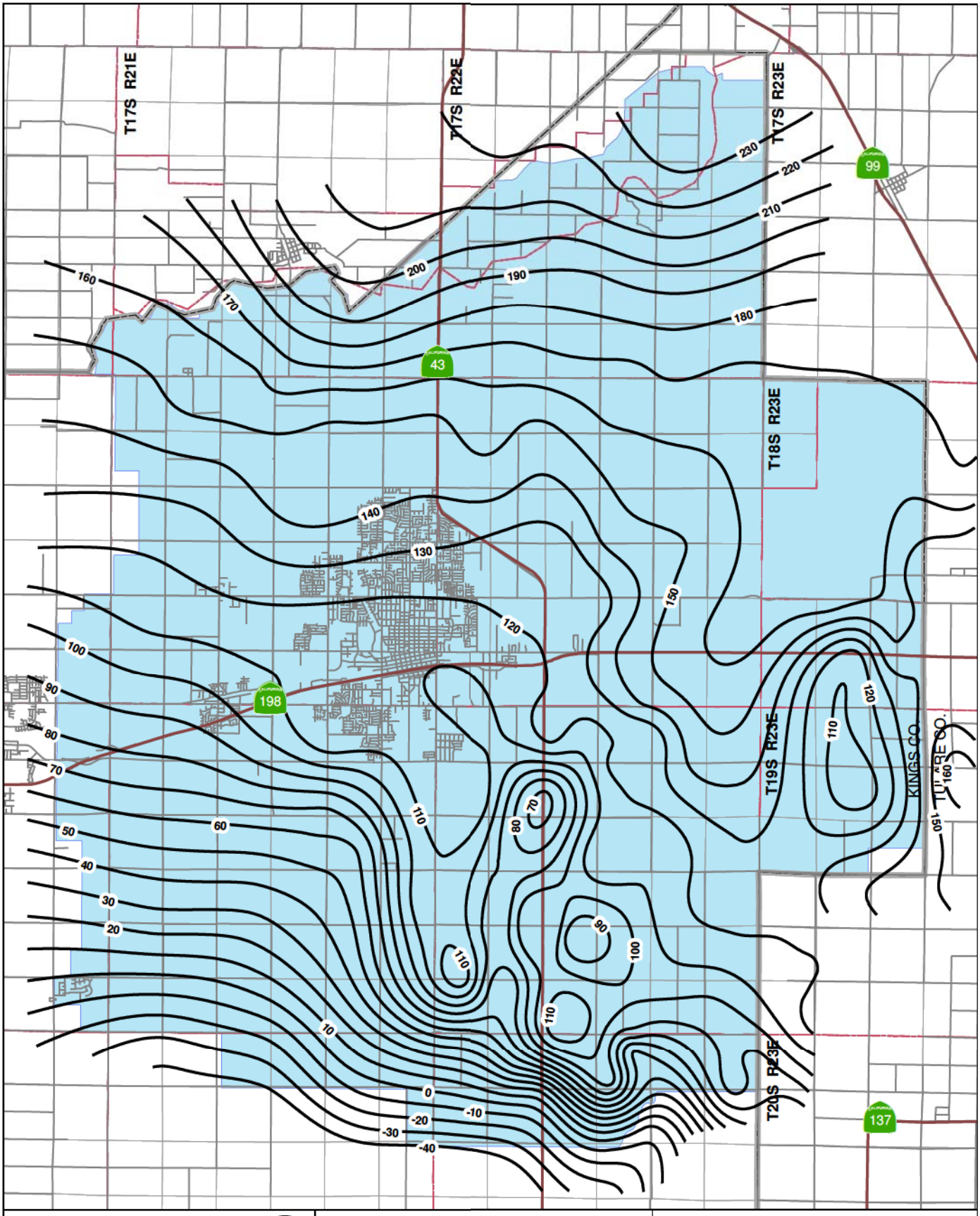
286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Kings County Water District

Figure 11

Hydrograph

file path & date 00/00/2005



0 1.25 2.5 Miles

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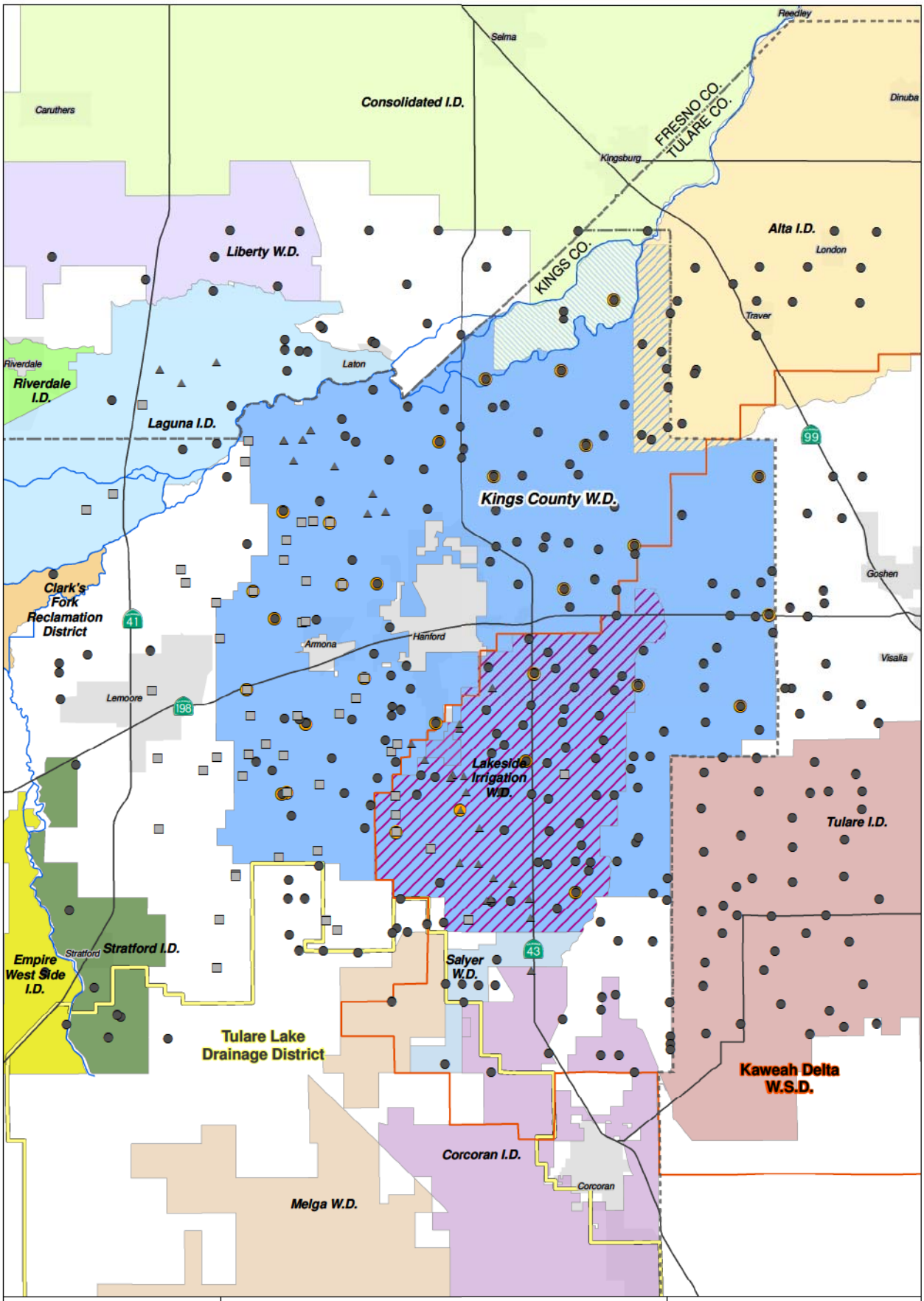
Legend

Spring 2010 GW Contour

Kings County Water District

Figure 12

Elevation of Groundwater Surface
Spring 2010



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11/9/2010 \\evolution\clv_clients\Clients\Kings County WD - 2192\PROJECTS\219208C1 - Groundwater Management Plan\GIS\Map\2010 Updated Figs\Fig13_Wells.mxd

Kings County Water District
Indicator Wells: Semi-Annual Depth To Water In Wells

Spring Measurements

Wells in Shallow Groundwater Area

Owner	T/R/S/Well	Aquifer Zone	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	1 Yr Change	5 Yr Change
Lina Simas Est.	182116F1	Shallow, Unconfined	24.0	25.0	26.0	27.0	29.0	31.0	32.4	31.7	29.6	29.8	30.3	30.6	-0.3	1.8
The Kondo Family	182128B1	Shallow, Unconfined	26.0	24.0	22.0	22.0	16.0	18.0	19.2	24.6	28.8	28.5	28.4	30.8	-2.4	-11.6
Joseph Duarte	182130D1	Shallow, Unconfined	12.0	9.0	10.0	10.0	14.0	17.0	16.6	18.6	15.3	13.6	15	16.5	-1.5	0.1
The Little Family Trust	192012A1	Shallow, Unconfined	10.0	8.0	10.0	11.0	17.0	17.0	17.6	12.5	17.0	16.9	19.2	22.5	-3.3	-4.9
Russell & Cyndi Verdegaal	192103M1	Shallow, Unconfined	14.2	13.2	11.2	11.2	14.2	15.2	17.7	16.4	72.6	77.1	66.7	76.2	-9.5	-58.5
Eddie Nixon	192120N1	Shallow, Unconfined	5.0	8.0	9.0	9.0	12.0	13.0	15.8	11.2	10.9	10.0	12	13	-1.0	2.8
S & A Souza Farms Inc.	192135D1	Shallow, Unconfined	19.5	17.5	19.5	17.5	21.5	25.5		19.7	18.5	15.9	20	21.2	-1.2	

Wells in Forebay and Lower Unconfined Groundwater Areas

Owner	T/R/S/Well	Aquifer Zone	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	1 Yr Change	5 Yr Change
Herman Kautz	172211P1	Unconfined	25.0	17.0	25.0	27.0	36.0	38.0		52.1	31.0	25.5	47	46.9	0.1	
Manuel Vieira	172228A1	Unconfined	44.0	28.0	39.0	44.0	52.0	71.0	74.3	65.8	63.0	51.4	62.6	75	-12.4	-0.7
Aldon Holder	172230A1	Not Available	30.5	18.5	17.5	13.5	14.5	15.5	17.7	16.8	47.8	41.9	53.7	66.1	-12.4	-48.4
Leland Tos	182101C1	Unconfined	69.5	64.5	60.5	61.5	67.5	66.5		88.6	91.4	76.5	81.4			
Roman Catholic Bishop	182107R3	Unconfined	83.0	83.0	82.0	81.0	79.0	45.0	48.4	30.9	29.7	29.8	30.5	27.1	3.4	21.3
John Souza	182127B1	Not Available	93.0	96.0	91.0	91.0	105.0			110.0	97.1	92.3	93.3	92.2	1.1	
Mary M. Baretto	182131B1	Unconfined	101.0	97.0	101.0	126.0	108.0	121.0	87.8	130.2	142.0	135.7	128.2	132.1	-3.9	-44.3
Laura M. Montgomery	182203B1	Unconfined	82.0	70.0	78.0	67.0	71.0	79.0	72.9	78.8	88.2	77.6	79.9	93.4	-13.5	-20.5
Mary E. Richards	182207A1	Unconfined	82.5	76.5	74.5	74.5	87.5	91.5		91.7	91.2	89.3	93.9	102.5	-8.6	
Louise Macedo	182224D1	Not Available	76.0	67.0	77.0	92.0	84.0	91.0	88.2	93.9	103.3	101.0	95.5	104	-8.5	-15.8
Mary R. Silva	182228A1	Unconfined	96.0	85.0	92.0	88.0	102.0	103.0	103.7	121.5	120.8	100.3	109.4	116	-6.6	-12.3
J-D-R Campisi	182304C1	Not Available	67.0	64.0	69.0	80.0	72.0	87.0	84.5	88.2	85.4	101.3	95	100.8	-5.8	-16.3
Robert Giacomazzi	182328R1	Composite	68.5	99.5	95.5	98.5	103.5	124.5		119.2	116.8	114.7	111.5	118.7	-7.2	
Building Technologies Corp.	192113C3	Composite	87.0	90.0	108.0		107.4	111.0	121.0	113.0	122.8	130.3	142.1	141.5	0.6	-20.5
Robert Sullivan	192117B2	Not Available	104.0	99.0	113.0		138.0				141.0	166.6	206.8	171.1	35.7	
Cal-Clark Farms Inc.	192125J1	Not Available	76.0	72.0	79.0		82.6		110.7	96.8	89.0	90.3	102.5	107.5	-5.0	3.2
Eimert Van Groningen	192130A1	Not Available	112.0	110.0	135.0	172.0	158.0	156.0	160.3	188.9	186.3		211.2	208	3.2	-47.7
Ralph & Sara Alcala	192201N2	Composite	69.0	48.0	65.0		89.0	79.5	100.0	101.2	73.7	67.4	84.5	102	-17.5	-2.0
Tony Dias	192204M1	Composite	97.0	90.0	80.0	100.0	96.0		124.5	106.4	100.2	110.3	105.3	114	-8.7	10.5
George Longfellow, Est.	192220A1	Composite	94.0	85.0	90.0		103.8	149.0	130.5	128.8	110.5	123.0	147.3	148	-0.7	-17.5
Zelma B. Bono	192308J1	Not Available	94.3	89.3	86.8	85.3	95.3	109.3	108.5	103.3	118.2	174.2		148.9		-40.4
Robert Stewart	202203P1	Composite		78.0	81.0	85.0	91.6		110.2	117.9	106.1	97.1	114.7	126.5	-11.8	-16.3

Blanks indicate that no measurements were taken.

2/4/2010

FIGURE 15

Kings County Water District
Groundwater Management Plan
Implementation Schedule

Task No.	Task[1]	2011				2012				2013				2014				2015			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Seek grant funds to install nested monitoring wells	■	■																		
2	Install ten nested monitoring wells					■	■	■	■												
3	Test water quality in nested montoring wells								■				■				■				■
4	Test Electrical Conductivity in all monitoring wells																■				
5	Identify potential areas for groundwater recharge	■	■	■	■																
6	Construct additional recharge facilities					■	■	■	■												
7	Perform District-wide water budget analysis					■	■														
8	Update Groundwater Management Plan																			■	■

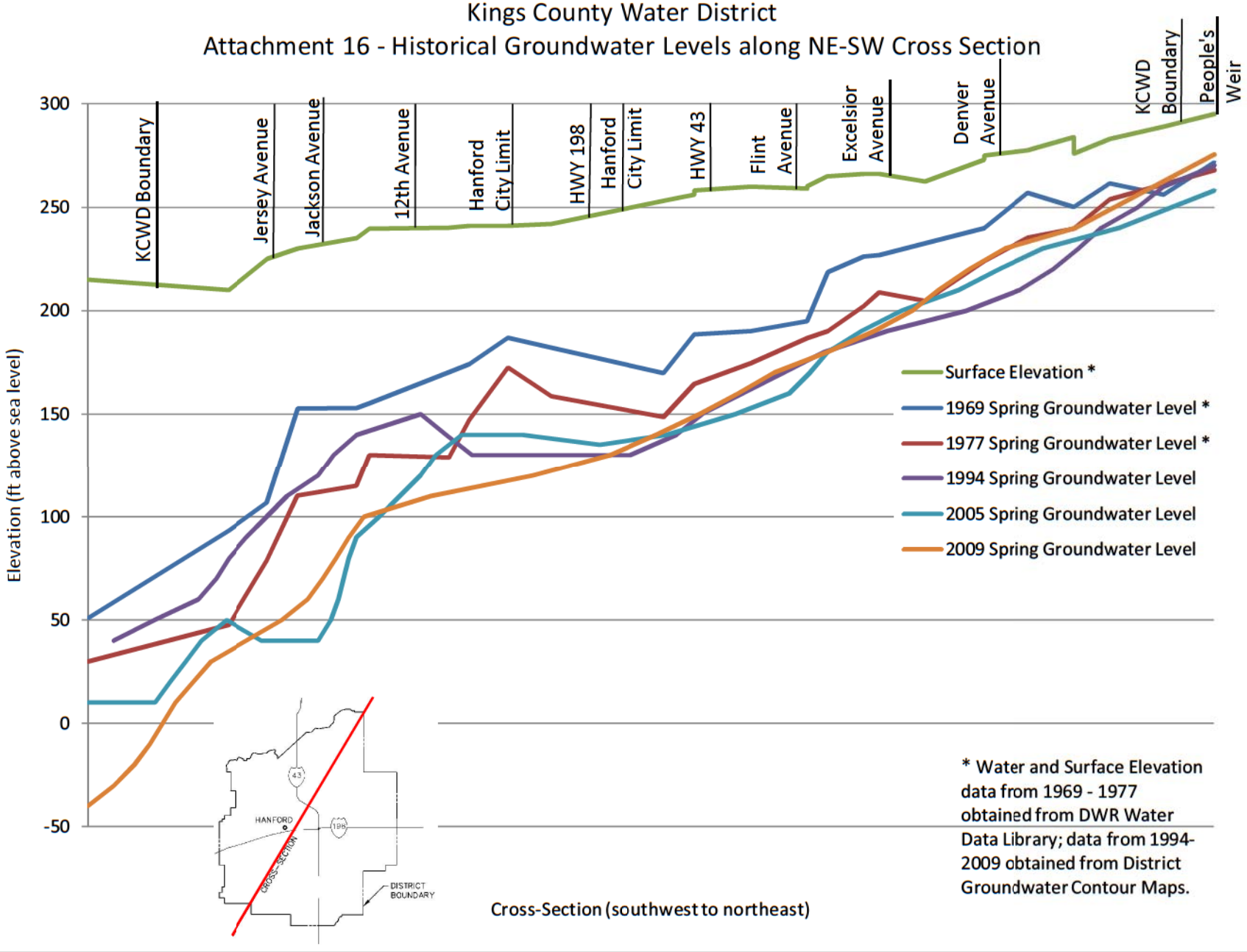
Notes:

1 - Only proposed new projects are shown in this schedule. Existing and on-going projects are not shown. Also, new policies and guidelines that will be implemented on a continuous basis are not shown.

2 - Implementation of some projects will depend on the results of feasibility studies and funding availability.

Kings County Water District

Attachment 16 - Historical Groundwater Levels along NE-SW Cross Section



KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX A – GROUNDWATER LEGISLATION

information in any manner to any person not entitled to receive it, is guilty of a misdemeanor punishable by a six month county jail term and a fine not to exceed one thousand dollars ($1,000).

(2) Any officer or employee of the district or of a district contractor, or former officer or employee, who, by virtue of that employment or official position has possession of, or has access to, any other confidential information acquired pursuant to this section, and who, knowing that the disclosure of the information to the general public is prohibited by this section, and who, knowing that the disclosure of the information to the general public is prohibited by this section, knowingly and willfully discloses the information in any manner to any person not entitled to receive it, is guilty of a misdemeanor punishable by a 10-day county jail term or a fine not to exceed five hundred dollars ($500).

(d) The penalties provided in subdivision (c) shall be in addition to any existing civil penalties and remedies available under the law.

(e) Except for the purposes of any enforcement or permit action, and except for information obtained from an independent source, all information received or compiled by an air pollution control officer from a supplier, wholesaler, or distributor pursuant to subdivision (a) is confidential for the purposes of Chapter 3.5 (commencing with Section 6250) of Division 7 of Title 1 of the Government Code, and shall not be disclosed.

SEC. 3. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs which may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, changes the definition of a crime or infraction, changes the penalty for a crime or infraction, or eliminates a crime or infraction. Notwithstanding Section 17580 of the Government Code, unless otherwise specified in this act, the provisions of this act shall become operative on the same date that the act takes effect pursuant to the California Constitution.

CHAPTER 903

An act to add Part 2.75 (commencing with Section 10750) to Division 6 of the Water Code, relating to water.

[Approved by Governor October 12, 1991. Filed with Secretary of State October 14, 1991]

The people of the State of California do enact as follows:

SECTION 1. Part 2.75 (commencing with Section 10750) is added to Division 6 of the Water Code, to read:

PART 2.75. GROUNDWATER RESOURCES

10750. This part applies only to local agencies whose jurisdiction includes the following groundwater basins subject to "critical conditions of groundwater overdraft" as identified by the Department of Water Resources' Bulletin 118-80, p. 3, as revised December 24, 1982: Pajaro Valley Basin; Cuyama Valley Basin; Ventura Central Basin; Eastern San Joaquin County Basin; Chowchilla Basin; Madera Basin; Kings Basin; Kaweah Basin; Tulare Lake Basin; Tule Basin; and Kern County Basin.

10751. (a) As used in this part, "local agency" means any city, county, district, agency, or other political subdivision of the state for the local performance of governmental or proprietary functions within limited boundaries.

(b) As used in this part, "groundwater" and "groundwater resources" do not include those subsurface waters incidentally produced in connection with, or as a result of, natural resource extraction activities when the disposal of those subsurface waters is regulated by state or federal law.

10752. Any local agency which is authorized by law to provide water service and is exercising that authority may, by ordinance, or by resolution if the local agency is not authorized to act by ordinance, establish programs for the management of groundwater resources within the area in which that water service is being provided.

10753. Prior to the adoption of a groundwater management program, the governing board of the local agency shall hold a public hearing, after publication of notice pursuant to Section 6066 of the Government Code, on the proposed groundwater management program. At the hearing, the board may alter the program or require further study on the program and continue the hearing. At the conclusion of the hearing, the board may adopt a resolution of intention to adopt and implement the program.

10754. After the conclusion of the hearing, and if the governing board of the local agency adopts a resolution of intention, copies of the groundwater management program shall be circulated to each owner of a water extraction, storage, or distribution facility within the local agency. Upon written request, any other interested person shall be provided with a copy of the program.

10755. After the adoption of a resolution of intention, the governing board of the local agency shall hold a second hearing and shall consider protests to the implementation of the program. Any time prior to the conclusion of the hearing, any landowner within the local agency may file a written protest or withdraw a protest previously filed.

10756. (a) A protest by a landowner shall include the landowner's signature and a description of the land owned sufficient to identify the land. A public agency owning land is deemed to be a landowner for the purpose of making a written protest.

(b) The secretary of the local agency shall compare the names and

property descriptions on the protest against the property ownership records of the county assessor.

10757. A majority protest shall be determined to exist if the governing board of the local agency finds that the protests filed and not withdrawn prior to the conclusion of the second hearing represents more than 50 percent of the assessed value of the land within the local agency. If the board finds that a majority protest exists, the groundwater management program shall be abandoned and no new program shall be considered by the board for a period of one year following the date of the second hearing. If a majority protest has not been filed, the board, within 35 days after the conclusion of the second hearing, may adopt an ordinance or resolution to implement the program.

10758. A local agency authorized to establish programs for the management of groundwater resources pursuant to this part may, for that purpose, enter into a joint powers agreement pursuant to Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the Government Code.

10759. A local agency which establishes a program for the management of groundwater resources pursuant to this part may fix and collect fees for the extraction of groundwater to pay the expenses incurred by the local agency for purposes of groundwater management including, but not limited to, administrative expenses and real costs associated with the acquisition of replenishment water.

10760. For purposes of groundwater management, a local agency authorized to establish programs for the management of groundwater resources pursuant to this part may exercise any of the powers of a water replenishment district under Part 4 (commencing with Section 60220) of Division 18 and may levy a water replenishment assessment in accordance with Part 6 (commencing with Section 60300) of Division 18.

10761. Before a local agency may levy a water replenishment assessment as authorized in Section 10760 or may otherwise fix and collect fees for the extraction of groundwater pursuant to this part, the local agency shall hold an election on the proposition of whether or not the local agency shall be authorized to levy a water replenishment assessment or to fix and collect fees for the extraction of groundwater. The local agency shall be authorized if a majority of the votes cast at the election is in favor of the proposition. The election shall be conducted in the manner prescribed by the principal act of the local agency.

10762. No local agency shall exercise the powers authorized by this part within the boundaries of another local agency providing water service to any or all of the lands within its boundaries, without the prior agreement of the governing body of that other local agency.

10763. All local agencies with overlapping boundaries which conduct groundwater management programs pursuant to this part shall, at least annually, meet for the purpose of coordinating their groundwater management programs.

10764. If a local agency annexes land subject to a groundwater management program of another local agency, the local agency annexing the land shall continue to comply with the groundwater management program for the annexed property.

10765. This part does not preempt, negate, affect, or imply the existence of any powers of a local agency in other groundwater basins of the state to establish programs for the management of groundwater resources.

10766. This part is in addition to, and not a limitation on, any powers of a local agency otherwise granted by law.

10767. This part does not exempt any local agency formed under any act requiring the approval of its leases, contracts, or issuance of securities by the Treasurer from obtaining the report, investigation, and approval of the Treasurer as required by that act or by the District Securities Investigation Law of 1965 (Chapter 2.5 (commencing with Section 58750) of Division 2 of Title 6 of the Government Code).

SEC. 2. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act. Notwithstanding Section 17580 of the Government Code, unless otherwise specified in this act, the provisions of this act shall become operative on the same date that the act takes effect pursuant to the California Constitution.

CHAPTER 904

An act to add Part 7 (commencing with Section 14940) to Division 12 of the Health and Safety Code, relating to cigarette lighters.

[Approved by Governor October 12, 1991. Filed with Secretary of State October 14, 1991.]

The people of the State of California do enact as follows:

SECTION 1. Part 7 (commencing with Section 14940) is added to Division 12 of the Health and Safety Code, to read:

PART 7. CIGARETTE LIGHTERS

14940. The Legislature finds and declares that unreasonable risks of death and serious bodily injury are caused by fires started by the operation of cigarette lighters by children. The Legislature further finds and declares that these risks are sufficiently severe to require the enactment of standards to reduce the risks.

14941. As used in this part, the following terms shall have the following meanings:

CHAPTER 947

An act to repeal and add Part 2.75 (commencing with Section 10750) of Division 6 of the Water Code, relating to water.

[Approved by Governor September 26, 1992. Filed with Secretary of State September 28, 1992.]

The people of the State of California do enact as follows:

SECTION 1. Part 2.75 (commencing with Section 10750) of Division 6 of the Water Code is repealed.

SEC. 2. Part 2.75 (commencing with Section 10750) is added to Division 6 of the Water Code, to read:

PART 2.75. GROUNDWATER MANAGEMENT

CHAPTER 1. GENERAL PROVISIONS

10750. The Legislature finds and declares that groundwater is a valuable natural resource in California, and should be managed to ensure both its safe production and its quality. It is the intent of the Legislature to encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions.

10750.2. (a) Subject to subdivision (b), this part applies to all groundwater basins in the state.

(b) This part does not apply to any portion of a groundwater basin that is subject to groundwater management by a local agency or a watermaster pursuant to other provisions of law or a court order, judgment, or decree, unless the local agency or watermaster agrees to the application of this part.

10750.4. Nothing in this part requires a local agency overlying a groundwater basin to adopt or implement a groundwater management plan or groundwater management program pursuant to this part.

10750.6. Nothing in this part affects the authority of a local agency or a watermaster to manage groundwater pursuant to other provisions of law or a court order, judgment, or decree.

10750.7. (a) A local agency may not manage groundwater pursuant to this part within the service area of another local agency, a water corporation regulated by the Public Utilities Commission, or a mutual water company without the agreement of that other entity.

(b) This section applies only to groundwater basins that are not critically overdrafted.

10750.8. (a) A local agency may not manage groundwater pursuant to this part within the service area of another local agency without the agreement of that other entity.

(b) This section applies only to groundwater basins that are critically overdrafted.

10750.9. A local agency that commences procedures, prior to January 1, 1993, to adopt an ordinance or resolution to establish a program for the management of groundwater pursuant to Part 2.75 (commencing with Section 10750), as added by Chapter 903 of the Statutes of 1991, may proceed to adopt the ordinance or resolution pursuant to that Part 2.75, and the completion of those procedures is deemed to meet the requirements of this part.

10750.10. This part is in addition to, and not a limitation on, the authority granted to a local agency pursuant to other provisions of law.

CHAPTER 2. DEFINITIONS

10752. Unless the context otherwise requires, the following definitions govern the construction of this part:

(a) "Groundwater" means all water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water, but does not include water which flows in known and definite channels.

(b) "Groundwater basin" means any basin identified in the department's Bulletin No. 118, dated September 1975, and any amendments to that bulletin, but does not include a basin in which the average well yield is less than 100 gallons per minute.

(c) "Groundwater extraction facility" means any device or method for the extraction of groundwater within a groundwater basin.

(d) "Groundwater management plan" or "plan" means a document that describes the activities intended to be included in a groundwater management program.

(e) "Groundwater management program" or "program" means a coordinated and ongoing activity undertaken for the benefit of a groundwater basin, or a portion of a groundwater basin, pursuant to a groundwater management plan adopted pursuant to this part.

(f) "Groundwater recharge" means the augmentation of groundwater, by natural or artificial means, with surface water or recycled water.

(g) "Local agency" means any local public agency that provides water service to all or a portion of its service area.

(h) "Recharge area" means the area that supplies water to an aquifer in a groundwater basin and includes multiple wellhead protection areas.

(i) "Watermaster" means a watermaster appointed by a court or pursuant to other provisions of law.

(j) "Wellhead protection area" means the surface and subsurface area surrounding a water well or well field that supplies a public water system through which contaminants are reasonably likely to migrate toward the water well or well field.

CHAPTER 3. GROUNDWATER MANAGEMENT PLANS

10753. (a) Any local agency, whose service area includes a groundwater basin, or a portion of a groundwater basin, that is not subject to groundwater management pursuant to other provisions of law or a court order, judgment, or decree, may, by ordinance, or by resolution if the local agency is not authorized to act by ordinance, adopt and implement a groundwater management plan pursuant to this part within all or a portion of its service area.

(b) Notwithstanding subdivision (a), a local public agency, other than an agency defined in subdivision (g) of Section 10752, may exercise the authority of this part within a groundwater basin if both of the following requirements are met:

(1) Water service is not provided by a local agency.

(2) The local public agency provides flood control, groundwater quality management, or groundwater replenishment.

10753.2. (a) Prior to adopting a resolution of intention to draft a groundwater management plan, a local agency shall hold a hearing, after publication of notice pursuant to Section 6066 of the Government Code, on whether or not to adopt a resolution of intention to draft a groundwater management plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management program.

(b) At the conclusion of the hearing, the local agency may draft a resolution of intention to adopt a groundwater management plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management program.

10753.3. (a) After the conclusion of the hearing, and if the local agency adopts a resolution of intention, the local agency shall publish the resolution of intention in the same manner that notice for the hearing held under Section 10753.2 was published.

(b) Upon written request, the local agency shall provide any interested person with a copy of the resolution of intention.

10753.4. The local agency shall prepare a groundwater management plan within two years of the date of the adoption of the resolution of intention. If the plan is not adopted within two years, the resolution of intention expires, and no plan may be adopted except pursuant to a new resolution of intention adopted in accordance with this chapter.

10753.5. (a) After a groundwater management plan is prepared, the local agency shall hold a second hearing to determine whether to adopt the plan. Notice of the hearing shall be given pursuant to Section 6066 of the Government Code. The notice shall include a summary of the plan and shall state that copies of the plan may be obtained for the cost of reproduction at the office of the local agency.

(b) At the second hearing, the local agency shall consider protests to the adoption of the plan. At any time prior to the conclusion of the second hearing, any landowner within the local agency may file a written protest or withdraw a protest previously filed.

10753.6. (a) A written protest filed by a landowner shall include the landowner's signature and a description of the land owned

sufficient to identify the land. A public agency owning land is deemed to be a landowner for the purpose of making a written protest.

(b) The secretary of the local agency shall compare the names and property descriptions on the protest against the property ownership records of the county assessors.

(c) (1) A majority protest shall be determined to exist if the governing board of the local agency finds that the protests filed and not withdrawn prior to the conclusion of the second hearing represent more than 50 percent of the assessed value of the land within the local agency subject to groundwater management pursuant to this part.

(2) If the local agency determines that a majority protest exists, the groundwater plan may not be adopted and the local agency shall not consider adopting a plan for the area proposed to be included within the program for a period of one year after the date of the second hearing.

(3) If a majority protest has not been filed, the local agency, within 35 days after the conclusion of the second hearing, may adopt the groundwater management plan.

10753.7. A groundwater management plan may include components relating to all of the following:

(a) The control of saline water intrusion.

(b) Identification and management of wellhead protection areas and recharge areas.

(c) Regulation of the migration of contaminated groundwater.

(d) The administration of a well abandonment and well destruction program.

(e) Mitigation of conditions of overdraft.

(f) Replenishment of groundwater extracted by water producers.

(g) Monitoring of groundwater levels and storage.

(h) Facilitating conjunctive use operations.

(i) Identification of well construction policies.

(j) The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.

(k) The development of relationships with state and federal regulatory agencies.

(*l*) The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

10753.8. (a) A local agency shall adopt rules and regulations to implement and enforce a groundwater management plan adopted pursuant to this part.

(b) Nothing in this part shall be construed as authorizing the local agency to make a binding determination of the water rights of any person or entity.

(c) Nothing in this part shall be construed as authorizing the local agency to limit or suspend extractions unless the local agency has

determined through study and investigation that groundwater replenishment programs or other alternative sources of water supply have proved insufficient or infeasible to lessen the demand for groundwater.

10753.9. In adopting rules and regulations pursuant to Section 10753.8, the local agency shall consider the potential impact of those rules and regulations on business activities, including agricultural operations, and to the extent practicable and consistent with the protection of the groundwater resources, minimize any adverse impacts on those business activities.

CHAPTER 4. FINANCES

10754. For purposes of groundwater management, a local agency that adopts a groundwater management plan pursuant to this part has the authority of a water replenishment district pursuant to Part 4 (commencing with Section 60220) of Division 18 and may fix and collect fees and assessments for groundwater management in accordance with Part 6 (commencing with Section 60300) of Division 18.

10754.2. (a) Subject to Section 10754.3, except as specified in subdivision (b), a local agency that adopts a groundwater management plan pursuant to this part, may impose equitable annual fees and assessments for groundwater management based on the amount of groundwater extracted from the groundwater basin within the area included in the groundwater management plan to pay for costs incurred by the local agency for groundwater management, including, but not limited to, the costs associated with the acquisition of replenishment water, administrative and operating costs, and costs of construction of capital facilities necessary to implement the groundwater management plan.

(b) The local agency may not impose fees or assessments on the extraction and replacement of groundwater pursuant to a groundwater remediation program required by other provisions of law.

10754.3. Before a local agency may levy a water management assessment pursuant to Section 10754.2 or otherwise fix and collect fees for the replenishment or extraction of groundwater pursuant to this part, the local agency shall hold an election on the proposition of whether or not the local agency shall be authorized to levy a groundwater management assessment or fix and collect fees for the replenishment or extraction of groundwater. The local agency shall be so authorized if a majority of the votes cast at the election is in favor of the proposition. The election shall be conducted in the manner prescribed by the laws applicable to the local agency or, if there are no laws so applicable, then as prescribed by laws relating to local elections. The election shall be conducted only within the portion of the jurisdiction of the local agency subject to groundwater management pursuant to this part.

CHAPTER 5. MISCELLANEOUS

10755. (a) If a local agency annexes land subject to a groundwater management plan adopted pursuant to this part, the local agency annexing the land shall comply with the groundwater management plan for the annexed property.

(b) If a local agency subject to a groundwater management plan adopted pursuant to this part annexes land not subject to a groundwater management plan adopted pursuant to this part at the time of annexation, the annexed territory shall be subject to the groundwater management plan of the local agency annexing the land.

10755.2. (a) It is the intent of the Legislature to encourage local agencies, within the same groundwater basin, that are authorized to adopt groundwater management plans pursuant to this part, to adopt and implement a coordinated groundwater management plan.

(b) For the purpose of adopting and implementing a coordinated groundwater management program pursuant to this part, a local agency may enter into a joint powers agreement pursuant to Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the Government Code with public agencies, or a memorandum of understanding with public or private entities providing water service.

(c) A local agency may enter into agreements with private parties for the purpose of implementing a coordinated groundwater management plan.

10755.3. Local agencies within the same groundwater basin that conduct groundwater management programs within that basin pursuant to this part shall, at least annually, meet to coordinate those programs.

10755.4. Except in those groundwater basins that are subject to critical conditions of groundwater overdraft, as identified in the department's Bulletin 118–80, revised on December 24, 1982, the requirements of a groundwater management plan that is implemented pursuant to this part do not apply to the extraction of groundwater by means of a groundwater extraction facility that is used to provide water for domestic purposes to a single-unit residence and, if applicable, any dwelling unit authorized to be constructed pursuant to Section 65852.1 or 65852.2 of the Government Code.

SEC. 3. The Department of Water Resources shall, on or before January 1, 1998, prepare and publish, in a bulletin of the department published pursuant to Section 130 of the Water Code, a report on the status of groundwater management plans adopted and implemented pursuant to Part 2.75 (commencing with Section 10750) of Division 6 of the Water Code.

KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX B - PUBLIC PARTICIPATION IN PLAN ADOPTION

Resolution will be added after it is adopted by the District

KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX C – ATTRIBUTES OF WELLS MONITORED BY KCWD

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
172001C1	Tulare	198585.021	34529.147	F	U	D	243.3	243.3	Liberty WD	
172002J2	California Department of Water Resources	196225.639	31778.815	F	U	D	241	240		
172006M1	California Department of Water Resources	196665.01	8640.04			D	230.9	230		
172009H1	California Department of Water Resources	192927.49	22111.39			D	233	232		
172011J1	California Department of Water Resources	191143.887	31584.701	F	U	D	240.5	240		
172022P1	California Department of Water Resources	179358.849	23648.681	F	U	B	236	235		
172024N1	California Department of Water Resources	179413.364	32429.979	F	U	B	237.3	235		
172026E1	California Department of Water Resources	177069.228	27521.18	F	U	B	236	235		
172028N1	California Department of Water Resources	175071.81	18332.98			D	230	230		
172033A1	California Department of Water Resources	173511.24	21779.011	A	U	S	232	231		
172036C3	Kings County Water District	172923.005	34433.142	F	U	D	241	241	Est.Coords.	Yes
172036F3	Kings County Water District	172400	34200	F	U	X	242	242	TERM.	
172101C1	Consolidated Irrigation District	198602.564	64119.01	F	U	D	268.7	268.7		
172103C1	Consolidated Irrigation District	198657.079	54028.699	F	U	D	261.9	261.9		
172105C1	Consolidated Irrigation District	198711.594	44374.726	F	U	D	252.1	252.1		
172107J1	California Department of Water Resources	191645.707	41877.204	F	U	D	258	257		
172111K1	California Department of Water Resources	190643.407	60519.223	F	U	D	258	257		
172113M1	California Department of Water Resources	185409.989	62809.997	F	U	D	261	260		
172116E1	California Department of Water Resources	187679.18	48695.8			D	249	249		
172117J1	California Department of Water Resources	185874.769	47148.975	F	U	D	249	249		
172119A2	California Department of Water Resources	183545.741	42007.307	F	U	D	244	243		
172119R1	California Department of Water Resources	179304.334	41974.868	F	U	D	245	245		
172120F1	California Department of Water Resources	182553.4	44732.6			D	249	247		
172120G1	California Department of Water Resources	181757.499	45901.908	F	U	D	249	248		Yes
172122C1	California Department of Water Resources	183447.457	54192.326	F	U	D	253	252.5		Yes
172122C2	California Department of Water Resources	182447	54100	F	U	D	254	253	added 11/94 estimated coord.	
172127L1	Kings County Water District	176145.612	55199.365	F	U	D	256	255		
172129D3	California Department of Water Resources	178377.582	42847.544	F	U	D	248	247		
172131R1	Kings County Water District	169263.434	41865.264	F	U	B	244.6	244		
172132K1	Kings County Water District	170628.945	45909.213	F	U	B	246.5	246		
172132P1	Kings County Water District	168990.332	44379.07	F	U	B	245.5	245		
172133G1	Kings County Water District	172868.384	50827.529	F	U	D	252	251		
172133Q1	Kings County Water District	169318.054	50226.401	F	U	D	247.5	247		
172135C1	Kings County Water District	172923.005	59352.61	F	U	D	258	258		
172136B1	California Department of Water Resources	173450.473	65391.908	F	U	D	264	263		
172201C1	Consolidated Irrigation District	198550.373	94197.937	F	U	D	300.7	300.7		
172203C1	Consolidated Irrigation District	198550.373	84400.633	F	U	D	284.6	284.6		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
172205C1	Consolidated Irrigation District	198504.274	74484.475	F	U	D	277	277	Discrepancy in base el. noted on 1994 printout from CID shows El. = 245.95	
172207A1	California Department of Water Resources	193706.971	71920.989	F	U	D	269.5	269		
172211P1	Kings County Water District	189391.782	89388.627	F	U	D	285	283		
172216H1	Kings County Water District	186654.948	81954.904	F	U	D	278	276		
172216J1	Kings County Water District	185638.782	82011.305	F	U	D	277.5	276		
172218N1	Kings County Water District	185033.541	68165.967	F	U	D	267	267		
172224E1	Kings County Water District	181029.005	93048.51	F	U	D	277.9	277.5		
172224J1	U.S. Bureau of Reclamation	180985.575	97097.588	F	U	D	278	278		Yes
172225A1	Alta Irrigation District	178438.68	97053.653	F	U	D	275	275		
172225J1	Alta Irrigation District	175496.576	96526.445	F	U	D	275	275		Yes
172228A1	Kings County Water District	178185.74	81949.098	F	U	D	275	273		
172230A1	Kings County Water District	178395.199	71785.236	F	U	D	265.5	265		
172231A1	Kings County Water District	173414.589	71866.992	F	U	D	263	262		
172231M1	Kings County Water District	170574.325	67823.044	F	U	D	259	259		
172232C1	Kings County Water District	173305.348	74490.094	F	U	D	263	262.5		
172233P1	Kings County Water District	169099.573	78534.043	F	U	D	266.5	266		
172235B1	U.S. Bureau of Reclamation	173213.153	90507.473	F	U	D	270	270		
172235N1	Kings County Water District	168957.807	87856.921	F	U	D	266.5	266		
172236J1	U.S. Bureau of Reclamation	170710.169	96658.247	F	U	D	268	268		
172236N1	Kings County Water District	168957.807	92993.862	F	U	D	266	266		Yes
172301A1	Alta Irrigation District	198558.293	126333.993	F	U	D	302	302		
172302A1		198602.206	121940.576	F	U	X	301	301	TERM.	Yes
172302B1	Alta Irrigation District	198558.293	120930.09	F	U	D	300	300		
172307B1	Kings County Water District	193646.41	101300.4	F	U	D	289	289		
172308J1	Kings County Water District	191133.85	107093.12	F	U	D	288.8	288		
172309B1	Alta Irrigation District	193552.318	110737.361	F	U	D	291.5	291.5		
172309Q1	U.S. Bureau of Reclamation	189424.584	110737.361	F	U	D	285	285		
172310A1	Alta Irrigation District	193684.054	117063.883	F	U	D	291.5	291.5		
172312C1	Alta Irrigation District	193508.406	124708.428	F	U	D	295	295		
172313C1	U.S. Bureau of Reclamation	188282.871	124488.758	F	U	D	288	288		
172315B1	Alta Irrigation District	188326.782	116009.462	F	U	D	286	286		
172318D1	U.S. Bureau of Reclamation	187967.582	98239.875	F	U	D	285	285		
172318E1	Alta Irrigation District	186650.223	98064.139	F	U	D	284	284		
172321C1	Alta Irrigation District	183062.036	109423.81	F	U	D	283	283		
172330A1	Kings County Water District	177751.75	102065.48	F	U	D	276	276		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
172330B1	Alta Irrigation District	178350.856	100480.514	F	U	D	276	276		
172331F1	Kings County Water District	171470.364	99114.472	F	U	D	270	270		
172636R1	Kings County Water District	169208.813	36673.708	A	U	S	243.8	243		
182001J2	Kings County Water District	166246.76	36400.027	A	U	S	240.5	240		
182002A1	California Department of Water Resources	168373.486	31576.412	A	CA	D	241	240		
182002E1	California Department of Water Resources	167368.43	28172.02			D	236	235		
182009M1	California Department of Water Resources	160469.249	18527.855	A	U	S	228	228		
182010P1	California Department of Water Resources	159020.139	24107.541	A	U	X	230	230	TERM.	Yes
182012C1	California Department of Water Resources	162796.607	33904.942	A	CA	D	240	239		
182013R1	Kings County Water District	154038.61	36473.92	A	CA	D	235	235		
182017D1	California Department of Water Resources	158273.628	12904.235	A	U	S	225.8	224.5		
182019N1	California Department of Water Resources	148760.653	7661.917	A	CA	D	217	217		
182022J1	Kings County Water District	150383.583	26462.889	A	U	S	233	233		
182026D1	Kings County Water District	147418.064	27593.18	A	U	S	235.5	235		
182026J1	Kings County Water District	145334.147	31484.313	A	U	S	236	236		
182034N1	California Department of Water Resources	138968.166	22511.813	A	CA	D	225.8	225		
182036M1	Kings County Water District	139826.779	32570.254	A	U	S	233	233		
182101C1	Kings County Water District	168131.722	63717.015	F	U	D	261	260.5		
182102R1	Kings County Water District	163910.629	61866.416	F	U	D	260.5	259.5		
182103D1	Kings County Water District	167624.82	52904.151	F	U	D	249.5	248		
182103J1	Kings County Water District	165330.761	56838.804	F	U	D	257	256		
182104L1	Kings County Water District	165003.039	49133.442	F	U	B	246.5	246		
182105M2	Kings County Water District	165003.038	42739.631	F	U	B	243	243		
182107R3	Kings County Water District	159080.511	41629.949	A	CA	D	240	240		
182108J1	Kings County Water District	160851.884	46947.524	A	CA	D	244	244		
182110F1	Kings County Water District	161725.811	53833.167	F	U	B	251	251		
182110R1	Kings County Water District	158940.168	55527.254	FE	U	B	255	254		
182112N1	Kings County Water District	159049.409	62740.784	F	U	D	254	253		
182114R1	Kings County Water District	154133.567	61593.176	FE	U	X	252	251	TERM.	Yes
182115C1	Kings County Water District	158120.861	54051.759	FE	U	B	252.5	252		
182116F1	Kings County Water District	156777.347	49548.204	A	U	S	248	245		
182117F1	Kings County Water District	156455.838	43841.106	A	U	S	248	245		
182117H1	Kings County Water District	155938.049	46713.928	A	U	S	245	245		
182117N1	Kings County Water District	153866.893	42663.72	A	U	S	238.2	238		
182119H1	Kings County Water District	151277.947	41674.716	A	U	S	240.5	240		
182120Q1	Kings County Water District	148831.5	45876.508	A	U	S	241	241		
182121H1	Kings County Water District	151671.769	51887.794	A	CA	D	250	250		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
182127B1	Kings County Water District	148031.55	55513.593	A	CA	D	246	246		
182128B1	Kings County Water District	147978.272	50666.565	A	U	S	244	243		
182130D1	Kings County Water District	147794.638	37718.699	A	U	S	238	237		
182131B1	Kings County Water District	142742.71	40529.736	A	CA	D	239	239		
182132A1	Kings County Water District	142659.378	46914.821	A	CA	D	238	238		
182132B1	Kings County Water District	142641.443	45822.449	A	U	S	238	238		
182132B2	Kings County Water District	142000	45800	A	U	S	238	238		Yes
182132C1	Kings County Water District	142500	44500	A	U	S	239	238		Yes
182134B2	Kings County Water District	142604.757	55603.862	A	CA	D	242	242		
182201C1	Kings County Water District	168200	94000	F	U	D	267	266	Est. Coords.	
182203B1	Kings County Water District	168236.451	85616.472	F	U	D	266	266		
182203M1	Kings County Water District	165134.35	82883.925	F	U	D	265.3	265		
182206D1	Kings County Water District	167734.061	68260.227	F	U	D	261.5	260.5		
182206E2	Kings County Water District	166477.791	68314.875	F	U	D	260	260		
182207A1	Kings County Water District	163268.889	71734.547	F	U	D	260.5	260		
182208A1	Kings County Water District	163145.943	76949.252	F	U	D	259	259		
182208N1	Kings County Water District	158885.547	72632.063	F	U	D	260	260		
182210C1	U.S. Bureau of Reclamation	162947.384	83974.836	F	U	D	263	263		Yes
182211P1	Kings County Water District	159000	90500	F	U	D	258	258	Est. Coords.	
182212C0	Lakeside Irrigation Water District	162870	94369	F	U	D	233.1	232	Est. Coords.	Yes
182214P	Lakeside Irrigation Water District	149019.52	79217.31			D	256.8	256		Yes
182215N0	Lakeside Irrigation Water District	159199	93118	FE	U	D	259.6	258	Est. Coords.	
182216L1	Kings County Water District	155062.115	78697.987	FE	U	D	258	258		
182217Q1	Kings County Water District	153805.845	75419.109	FE	U	D	255.5	255		
182219H2	Kings County Water District	151180.184	71287.853	FE	U	D	253	253		
182220D1	U.S. Bureau of Reclamation	152715.831	72595.839	FE	U	D	255	255		
182221C1	Kings County Water District	152768.056	79080.522	FE	U	D	256.3	256		
182222A1	U.S. Bureau of Reclamation	152935.392	86918.437	FE	U	D	257	257		
182222R	Lakeside Irrigation Water District	149007.56	86787.91			D	257	257		
182224D1	Kings County Water District	152481.747	93005.344	FE	U	D	259	258		
182224E1	U.S. Bureau of Reclamation	151310.639	92937.444	FE	U	D	251	251		Yes
182226F1	U.S. Bureau of Reclamation	146480.292	89774.171	FE	U	D	255	255		
182227M2	Kings County Water District	144388.452	82870.032	FE	U	D	251	251		
182228A1	Kings County Water District	147873.648	81898.425	FE	U	D	255	255		
182229B0	Lakeside Irrigation Water District	147782	75401	FE	U	D	250.5	250	Est.Coords.	
182232J1	Kings County Water District	140592.587	76580.114	FE	U	D	247.8	247		
182234R1	Kings County Water District	138572.594	86904.84	FE	U	D	242.7	242.7		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
182235C1	U.S. Bureau of Reclamation	142305.19	88925.851	FE	U	D	256	256		
182302Q1	Kings County Water District	163957.353	121651.841	F	U	D	278.5	276		
182304Q1	Kings County Water District	163754.56	110743.35	F	U	D	266	264		
182312B1	Kings County Water District	162947.374	125518.057	F	U	D	281.5	280		
182314A1	Kings County Water District	157985.3	122047.249	F	U	D	279	278		
182315A1	Kings County Water District	157867.56	117068.81	F	U	D	274.4	271.6		
182316R1	Kings County Water District	153825.63	111603.99	F	U	X	263	263	TERM.	Yes
182318C1	Kings County Water District	157900	99000	F	U	D	260	259	Est. Coords.	
182321J1	Kings County Water District	149892.93	111440.05	FE	U	D	264	264		
182321Q1	Kings County Water District	148763.746	111678.762	FE	U	X	263	263		
182324K1	Kings County Water District	150125.023	125474.122	F	U	X	280	280		
182326F1	Kings County Water District	146348.578	119015.784	F	U	D	274	274		
182326L1	Kings County Water District	144813.21	119200.09	F	U	D	273	273		
182327P1	Kings County Water District	143393.07	114336.4	FE	U	D	268	268		
182328B1	Kings County Water District	147762.72	110565.67	FE	U	D	263	263		
182328R1	Kings County Water District	143646.48	111634	FE	U	D	267.5	266		
182329D1	Kings County Water District	147676.7	102872.27	FE	U	D	256	256		
182329H1	Kings County Water District	145500	107000	FE	U	D	263	260	Est.Coords.	
182332B1	Kings County Water District	142464.51	106029.87	FE	U	D	259.5	258.5		
182332P2	U.S. Bureau of Reclamation	138645.593	104380.354	FE	U	D	255	255		
182333C1	Kings County Water District	142300.65	108980.87	FE	U	D	264	264		
182333J1	Kings County Water District	140446.023	111585.701	FE	U	D	265.5	265		
182334A1	Kings County Water District	142389.47	116923.41	FE	U	D	272	271		
182334A2	Kings County Water District	142466.019	116198.882	FE	U	D	272	271		
192001C0	Kings County Water District	137700	32700	A	U	S	236	235		Yes
192005C1	California Department of Water Resources	137299.491	14120.303	A	CA	D	216	215		
192006C1	California Department of Water Resources	137562.966	8892.086	A	CA	D	214	213		
192006L1	California Department of Water Resources	134928.217	8760.283	A	CA	D	213.4	212		
192007F1	California Department of Water Resources	131239.567	8804.217	A	CA	D	210.5	210		
192010D1	Kings County Water District	132791.82	22555.473	A	U	S	222	221		
192012A1	Kings County Water District	132671.22	36672.694	A	U	S	231	231		
192012R1	Kings County Water District	128369.845	36552.034	A	U	S	230.5	229		
192013N0	Kings County Water District	123400	32300	A	U	S	223	223		
192013R0	Kings County Water District	124000	36000	A	CA	S	226	225		
192019A1	California Department of Water Resources	122230.162	11378.543	A	CA	D	212	210		
192022C1	Kings County Water District	122401.393	23994.754	A	U	S	221.5	220		
192023G1	Kings County Water District	121500	30000	A	U	S	225	224	Est.Coords.	

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
192024K1	Kings County Water District	120215.633	34753.433	A	S	S	222	222		
192025E1	Kings County Water District	115949.682	32414.892	A	X	X	221	220	TERM.	Yes
192034C1	Kings County Water District	112488.871	23853.509	A	U	S	214	213		
192102F1	Kings County Water District	135456.724	58712.037	A	CA	D	240	240		
192102N1	Kings County Water District	133650	57700	A	U	X	239	239	TERM.	Yes
192102N2	Lakeside Irrigation Water District	133882	57850	A	U	S	241	240	Est. Coords.	Yes
192103B1	Kings County Water District	137798.148	55439.918	A	CA	D	242	241		
192103J1	Kings County Water District	135238.242	56526.112	A	CA	D	242	241		
192103M1	Kings County Water District	134767.269	52652.515	A	U	S	236.8	236		
192104R1	Kings County Water District	133599.623	51498.483	A	X	X	240	240	TERM.	Yes
192107R1	Kings County Water District	128483.4	41545.424	A	U	D	228	228		
192108P1	Kings County Water District	129000	44000	A	CA	D	232	230		
192108P2	Kings County Water District	128000	44000	A	U	S	231	230		
192109K1	Kings County Water District	130338.587	50545.923	A	U	S	233	233		
192109R2	Kings County Water District	128300	51500	A	CA	D	236	235		
192110D1	Kings County Water District	132388.772	52959.121	A	U	S	235	235		
192110R0	Lakeside Irrigation Water District	128663	56579	A	CA	D	240	240	Est. Coords	
192110R1	Kings County Water District	128301.421	56744.704	A	X	S	235	235		Yes
192111B1	Kings County Water District	132725.693	60460.777	A	CA	D	241.5	240		
192111L2	Kings County Water District	129393.834	58985.278	A	CA	D	238	237		Yes
192111M1	Kings County Water District	129339.214	57728.371	A	CA	D	239	238		
192113A1	Kings County Water District	127323.5	66538.919	FE	U	B	239.6	239.6		
192113C3	Kings County Water District	127436.088	63602.43	A	CA	D	235.5	234.5		
192113J1	Lakeside Irrigation Water District	124914.942	66472.072	FE	U	B	238	236		
192114K	Lakeside Irrigation Water District	124829.57	60291.83			B	230.5	230		
192114M2	Kings County Water District	124500	57500	A	U	S	232	232		
192115J2	Kings County Water District	125133.425	56526.112	A	CA	D	236	235		
192115R1	Kings County Water District	123411.641	56567.093	A	U	S	233	233		
192117B2	Kings County Water District	127343.522	46264.372	A	CA	D	232	231		
192117B3	Kings County Water District	127209.009	45104.652	A	CA	D	231	230		
192118L1	Kings County Water District	126000	40000	A	U	S	231	230		
192118R1	Kings County Water District	123400	41500	A	U	S	229	227	Est.Coords.	
192119D2	Kings County Water District	122430.27	37564.55	A	CA	D	225	225		
192119G1	Kings County Water District	120500	41000	A	CA	D	229	228		
192120N1	Kings County Water District	118396	42630	A	U	S	225	225		
192120R1	Kings County Water District	118366.448	46779.193	A	U	S	225	225	Replaces 20R2	
192120R2	Kings County Water District	118400	42000	A	U	X	226.5	226	TERM.	Yes

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
192121C1	Kings County Water District	122426.616	48629.31	A	CA ?	D	229	229		
192122K0	Kings County Water District	119000	55000	A	CA	D	230	230		
192123A2	Kings County Water District	122724	61320	A	CA ?	B	230	230		
192123D1	Kings County Water District	122500	57500	A	CA	D	231	231		
192123J1	Lakeside Irrigation Water District	120381.43	61826.981	A	CA	D	230.2	230		
192124H1	Lakeside Irrigation Water District	120326.809	66144.184	FE	U	B	230	230		
192124K1	Lakeside Irrigation Water District	119155.716	65308.741	FE	U	B	229	228		
192124L1	Lakeside Irrigation Water District	120381.43	63685.017	A	CA	D	229	228		Yes
192125J1	Kings County Water District	114729.819	66418.164	FE	U	B	227	226		
192126B1	Lakeside Irrigation Water District	117503.029	59871.164	A	CA	D	225	225		
192126D1	Lakeside Irrigation Water District	117793.71	58279.25			S	225.5	225		
192126M1	Lakeside Irrigation Water District	115293.22	58279.25			S	233	223		
192127F2	Kings County Water District	116000	54000	A	CA	D	231	230		
192127J0	Lakeside Irrigation Water District	114784	56471	A	CA	D	226	225	Est. Coords.	Yes
192128B1	Kings County Water District	117314.745	50593.487	A	CA	D	226	225		
192129M1	Kings County Water District	114725.833	42587.37	A	CA	D	211.5	210.5		
192130A1	Kings County Water District	117289.457	41339.591	A	CA	D	225	225		
192130D2	Kings County Water District	117079.389	37595.32	A	CA	D	220	220		Yes
192131Q1	Kings County Water District	108477.323	39982.025	A	U	S	218	218		
192132J1	Kings County Water District	110165.71	46779.193	A	U	S	222	221		
192134D1	Kings County Water District	111812	52448	A	CA	D	225.9	225.4		
192135D1	Kings County Water District	112608.962	57533.665	A	U	S	225.5	225		
192135E0	Lakeside Irrigation Water District	110990	57723	A	U	D	223	223	Est. Coords.	Yes
192136M1	Lakeside Irrigation Water District	109482.315	62706.287	A	U	S	221	220		
192201D1	Lakeside Irrigation Water District	137623	93112	FE	U	D	245	245	Est. Coords.	
192201N2	Kings County Water District	133667.911	92943.522	FE	U	D	245	245		
192202K1	Kings County Water District	135849.993	90639.316	FE	U	D	245	244.8		
192203J1	Lakeside Irrigation Water District	135045	86815	FE	U	D	247.5	247	Est. Coords.	
192204B1	Lakeside Irrigation Water District	137805.412	80461.994	FE	U	D	245.5	245		
192204J1	Lakeside Irrigation Water District	135402.104	81773.55	FE	U	D	246	245		
192204M1	Kings County Water District	134549.244	77811.961	FE	U	D	244	243		
192206H1	Lakeside Irrigation Water District	136349	71720	FE	U	D	245	245	Est. Coords.	
192207A1	Lakeside Irrigation Water District	132780.313	71772.941	FE	U	B	242.5	242		Yes
192207K1	Lakeside Irrigation Water District	130099	70444	FE	U	D	240	240	Est. Coords.	
192209J1	Kings County Water District	129870.444	81828.273	FE	U	D	244.4	241.4		
192209M1	Lakeside Irrigation Water District	130082	78097	FE	U	D	240	240	Est. Coords.	
192210C1	Lakeside Irrigation Water District	132409	84436	FE	U	D	244.5	244	Est. Coords.	

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
192210R2	Kings County Water District	128333.495	86617.18	FE	U	D	241.5	241.5		
192211C0	Lakeside Irrigation Water District	132372	89338	FE	U	D	245	245	Est. Coords.	
192213H1	Kings County Water District	127000	95800	FE	U	D	243.5	243	Est. Coords.	
192214M1	Lakeside Irrigation Water District	124615.776	87952.31	FE	U	D	244	242		
192215M1	Lakeside Irrigation Water District	124288.052	82760.736	FE	U	D	241	240		
192216A2	Kings County Water District	127411.326	81960.078	FE	U	D	238	238		
192217A1	Lakeside Irrigation Water District	127073.706	76421.55	FE	U	D	235	235		
192217E1	Kings County Water District	126313.505	72689.808	FE	U	D	235	235		Yes
192217L1	Kings County Water District	124732.644	73656.377	FE	U	D	235	234.4		
192218R0	Lakeside Irrigation Water District	123581	71521	FE	U	D	235.5	235	Est. Coords.	
192219M1	Lakeside Irrigation Water District	119889.844	67455.739	FE	U	B	231.1	231		
192220A1	Kings County Water District	122530.381	76380.658	FE	U	D	233	232		
192221C1	Kings County Water District	122405.265	80026.941	FE	U	D	231	231		
192221J1	Lakeside Irrigation Water District	119872	81701	FE	U	S	233.5	233	Est. Coords.	
192222A1	Kings County Water District	122405.265	86880.79	FE	U	D	239	237		
192223A1	Kings County Water District	122475.545	91979.598	FE	U	D	241.5	241		
192223H0	Lakeside Irrigation Water District	121020	91764	FE	U	D	240	240	Est. Coords.	
192224B1	Kings County Water District	122519.517	95767.219	FE	U	D	241.2	241		
192224N1	Kings County Water District	118500	93500	FE	U	D	243	240	Est.Coords.	
192226C1	Lakeside Irrigation Water District	117220	89301	FE	U	D	237	237	Est. Coords.	
192226D0	Lakeside Irrigation Water District	117273	88071	FE	U	D	237	237	Est. Coords.	Yes
192227A	Lakeside Irrigation Water District	117213.07	86710.42			D	237	237		
192227P0	Lakeside Irrigation Water District	113552	84246	FE	U	D	233	233	Est. Coords.	
192228C1	Lakeside Irrigation Water District	117294	79189	FE	U	D	230	230	Est. Coords.	
192228D1	Kings County Water District	116740.511	77962	FE	U	D	230	230		
192229D1	Lakeside Irrigation Water District	117314	72902	FE	U	D	230	230	Est. Coords.	
192230D1	Kings County Water District	117443.116	67725.162	FE	U	B	229.5	228		
192231B2	Kings County Water District	112524.88	70185.518	FE	U	B	225	224		
192232D1	Lakeside Irrigation Water District	111857.864	73368.022	FE	U	D	227	226		
192233B1	Lakeside Irrigation Water District	112154	80492	FE	U	D	231	231	Est. Coords.	
192234L1	Kings County Water District	110596.666	84230.545	FE	U	D	233.5	232		
192236E1	Kings County Water District	111184.148	92947.624	FE	U	D	236	234.3		
192236E2	Kings County Water District	110414.543	92941.122	FE	U	D	235	234		
192302F1	Kings County Water District	135966.904	119537.945	FE	U	D	271	271		
192306H1	Kings County Water District	136420.861	101974.548	FE	U	D	252	252		
192307A2	Kings County Water District	132732.178	101798.809	FE	U	D	251.5	251		
192308J1	Kings County Water District	129792.91	106408.05	FE	U	D	256.7	256		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
192310C1	Kings County Water District	132522.93	114326.64	FE	U	D	266	265		
192310D1	Kings County Water District	131980.28	112818.52	FE	U	D	266.5	265		
192310Q1	Kings County Water District	128282.139	115847.401	FE	U	D	265.6	265		
192311C1	Kings County Water District	132221.45	119454.24	FE	U	D	267	267		
192312L1	Kings County Water District	129555.615	124151.125	FE	U	D	271.6	271		
192313A3	Tulare	127096.49	126260.007	FE	U	D	277	277		
192316C1	Kings County Water District	127000	109000	FE	U	D	258.5	257.5	Est.Coords.	
192318A1	Kings County Water District	125979.35	99083.77			D	246	246	Copy of 192318B1	
192318B1	Kings County Water District	125979.35	99083.77	FE	U	D	246	246	Copy of 192318F1	Yes
192318F1	Kings County Water District	125979.35	99083.77	FE	U	D	246	246		Yes
192319H1	Tulare	120587.341	101742.407	FE	U	D	248	248		
192320C1	Kings County Water District	122272.88	103588.83	FE	U	D	253	252		
192321C1	Kings County Water District	122387.778	109079.588	FE	U	D	255	254.4		
192321P1	Tulare	118216.034	109079.588	FE	U	D	255	255		
192322H1	Kings County Water District	120762.994	116724.315	FE	U	X	263	262.6		
192323D1	Tulare	121685.169	117998.436	FE	U	D	264	264		
192324L1	Tulare	119665.166	123622.144	FE	U	D	271	271		
192325C1	Tulare	116986.466	124500.848	FE	U	D	270.5	270.5		
192325L2	Tulare	114746.899	123490.338	FE	U	D	267.5	267.5		
192326B1	Tulare	116898.64	120766.355	FE	U	D	265	265		
192327A1	Tulare	117337.772	116768.251	FE	U	D	262	262		
192327P1	Tulare	113385.592	114176.073	FE	U	D	258	258		
192330H2	Tulare	115625.16	101522.732	FE	U	D	246	246		
192331R1	Tulare	108291.67	101654.538	FE	U	D	243	243		
192332H1	Tulare	110794.719	106882.828	FE	U	D	250.5	250.5		
192334L1	Tulare	109609.065	113648.85	FE	U	D	255	255		
192335H1	Tulare	110882.545	121688.994	FE	U	D	263	263		
202001G1	Kings County Water District	105221.147	34914.312	A	U	S	215	215		Yes
202001G2	Kings County Water District	105984.942	34150.134	A	U	S	216	215		Yes
202007H1	California Department of Water Resources	100711.219	10832.927	A	CA	D	202	201		
202012M1	California Department of Water Resources	99042.539	32317.011	A	U	S	209	208		
202019D1	California Department of Water Resources	92060.432	7406.018	A	CA	D	203	203		
202020L1	California Department of Water Resources	89601.325	13205.403	A	CA	D	197	196		Yes
202023A1	California Department of Water Resources	92060.432	30998.969	A	U	S	205.5	204		Yes
202028E2	California Department of Water Resources	86044.402	17467.071	A	CA	D	195	194		
202028E3	California Department of Water Resources	85385.712	17598.875	A	CA	D	193.5	193		
202029R1	California Department of Water Resources	83146.169	16500.507	A	CA	D	192	191		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
202030J1	California Department of Water Resources	84551.373	10920.796	A	CA	D	196	195		
202034B1	California Department of Water Resources	82092.266	25287.453	A	CA	D	190	190		
202101A1	Lakeside Irrigation Water District	107259.299	66568.744	FE	U	B	219	219		
202101L1	Kings County Water District	104780.494	63955.776	A	CA	D	221	220		
202103A2	Kings County Water District	107000	56500	A	CA	D	221	220		Yes
202105A1	Kings County Water District	107181.74	46719.48	A	CA	D	221	221		
202105E1	Kings County Water District	106064.75	42587.37	A	CA	D	220	219		
202108C1	California Department of Water Resources	102327.157	43915.791	A	CA	D	216	215		
202108D1	California Department of Water Resources	101712.38	42509.878	A	CA	D	216	215		
202109M1	Kings County Water District	98679.05	47846.63	A	U	S	214	214		
202109P	Lakeside Irrigation Water District	98190.7	9107.33			S	214	214		
202111D1	Kings County Water District	101891.97	57606.549	A	CA	D	218	217		
202111N1	Kings County Water District	98023.222	57513.653	A	CA	D	215	215		
202111P1	California Department of Water Resources	97935.889	58721.818	A	CA	D	215	215		Yes
202112N2	California Department of Water Resources	97935.889	62412.341	A	CA	D	216	215		Yes
202112P	Lakeside Irrigation Water District	98155.74	63947.6			D	212	212		
202114D1	California Department of Water Resources	96574.596	57623.447	A	CA	D	215	215		Yes
202115M1	California Department of Water Resources	93895.922	52527.011	A	CA	D	211	210		Yes
202116M1	California Department of Water Resources	93808.097	47869.923	A	CA	D	209	208		
202117D1	California Department of Water Resources	96574.596	42334.139	A	CA	D	212	211		
202117L2	California Department of Water Resources	94247.223	44443.009	A	CA	D	208	208		
202122R1	California Department of Water Resources	87967.709	56612.947	A	CA	D	208	207		Yes
202124G1	California Department of Water Resources	90646.383	64565.145	A	CA	D	210.5	210		
202124H1	California Department of Water Resources	90514.645	66498.276	A	CA	D	211.5	211		
202127D1	California Department of Water Resources	87133.368	52395.207	A	CA	D	209	207		Yes
202136P1	Kings County Water District	77855.878	64317.058	A	CA	D	203	203		
202201H1	Tulare	105744.712	96645.923	FE	U	D	237	237		
202201Q1	Kings County Water District	103225.283	95601.915	FE	U	D	235	233		
202202C1	Kings County Water District	107144.42	89267.812	FE	U	D	233	232		
202203B1	Lakeside Irrigation Water District	107307.233	85829.093	FE	U	D	229	229		
202203C2	Kings County Water District	107303.211	84274.481	FE	U	D	229	229		
202203G0	Lakeside Irrigation Water District	105843	85513	FE	U	D	230	230	Est. Coords.	
202203P1	Lakeside Irrigation Water District	103155.39	85549.118	FE	U	D	227.3	226.3		
202204C1	Kings County Water District	107259.299	79617.388	FE	U	D	225	225		
202204D1	Lakeside Irrigation Water District	107265.01	77685.454	FE	U	D	226	225		
202205L1	Lakeside Irrigation Water District	104645.535	74031.211	FE	U	B	222	222		
202206C1	Lakeside Irrigation Water District	107122.516	68878.015	FE	U	B	222	222		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
202206H1	Lakeside Irrigation Water District	105356.182	71669.958	FE	U	B	221	221		
202207A2	Lakeside Irrigation Water District	102107.636	71770.725	FE	U	B	218.5	217.5		
202207A3	Kings County Water District	102107.595	71155.365	FE	U	B	220.5	219.5		
202207A4	Lakeside Irrigation Water District	102076.686	70594.033	FE	U	D	220	219		
202207M1	Kings County Water District	99552.99	67613.119	A	U	S	217	216.4		
202208A2	Kings County Water District	102384.987	76278.342	FE	U	B	221	221		
202208C0	Lakeside Irrigation Water District	101934	73971	FE	U	D	221.7	221	Est. Coords.	
202208J1	Lakeside Irrigation Water District	99366.439	76358.308	FE	U	B	221	220		
202209H1	Lakeside Irrigation Water District	100331.15	81847.863	FE	U	D	225	225		
202210J1	Lakeside Irrigation Water District	99417	86626	FE	U	D	226	225	Est. Coords.	
202212A1	Kings County Water District	102300	96800	FE	U	D	237	235	Est. Coords.	
202213C2	Kings County Water District	96789.248	94151.124	FE	U	D	228.5	228		
202214C1	Kings County Water District	96792.768	89267.806	FE	U	D	224.5	224		
202218R1	California Department of Water Resources	93193.319	71375.04	A	CA	D	213	213		
202219J1	California Department of Water Resources	89241.177	71243.235	A	CA	D	213.5	213		
202219L1	California Department of Water Resources	89504.653	68431.407	A	CA	D	211	211		
202219N1	California Department of Water Resources	87949.358	67372.456	A	CA	D	209	209		
202220A2	Kings County Water District	92151.689	76495.945	FE	U	B	216	216		
202223M1	Kings County Water District	89239.699	87686.135	FE	U	D	223.5	223		
202223P1	California Department of Water Resources	87966.217	88784.518	FE	U	D	221	220		
202224R1	Kings County Water District	87787.053	96875.11	FE	U	D	224.5	224		
202225R1	Tulare	82859.802	96615.7	FE	U	D	221	221		
202227A1	Kings County Water District	87000.127	86763.494	FE	U	D	216.5	216		
202228H1	Kings County Water District	85199.686	81447.323	FE	U	D	214.5	214		
202231R1	California Department of Water Resources	77855.878	69896.853	A	CA	D	210	205		
202233F1	Kings County Water District	80588.801	78943.011	A	CA	D	211	210		
202234J1	California Department of Water Resources	79754.45	86851.364	FE	U	D	213.5	213		
202235L1	Kings County Water District	79490.972	88916.323	FE	U	D	211	211		
202235R1	California Department of Water Resources	77866.184	91903.924	FE	U	D	219	216		
202236A1	Kings County Water District	82069.365	96703.571	FE	U	D	220.2	219.2		
202236H1	California Department of Water Resources	80444.577	96659.635	FE	U	D	221.5	220		
202302H1	Tulare	105612.973	121820.8	FE	U	D	258	258		
202303L1	Tulare	104602.971	114176.073	FE	U	D	251.5	251.5		
202304F1	Tulare	105832.538	109431.07	FE	U	D	246	246		
202305J1	Kings County Water District	104732.64	106098.42	FE	U	D	242	242		
202307H3	Tulare	100082.73	101488.312	FE	U	D	237	237		
202308G1	Kings County Water District	100451.73	105495.17	FE	U	D	241	241		

KINGS COUNTY WATER DISTRICT

ATTRIBUTES OF WELLS MONITORED BY KCWD

Well_ID	Monitoring Agency	Northing	Easting	HyGeo1	HyGeo2	MapUse	Ref_Elev	Ground_Elev	Comments	Discontinued
202308H1	Tulare	100126.64	106584.8	FE	U	D	242	242		
202309J2	Tulare	99336.21	111461.61	FE	U	D	245.5	245.5		
202311C1	Kings County Water District	102099.925	119711.91	FE	U	X	253	253		
202311L1	Tulare	99467.949	119413.89	FE	U	D	250	250		
202312A1	Tulare	102099.925	125906.774	FE	U	D	256	256		
202313E2	Tulare	95691.419	122796.9	FE	U	D	250	250		
202315A1	Tulare	96964.9	116602.03	FE	U	D	247	247		
202316J1	Tulare	94242.286	111637.35	FE	U	D	242	242		
202317C1	Tulare	97008.813	104256.23	FE	U	D	238	238		
202318R1	Tulare	93012.718	101751.92	FE	U	D	234.5	234.5		
202319J1	Tulare	89148.361	101795.85	FE	U	D	231	231		
202321B1	Tulare	92046.628	110978.32	FE	U	D	239	239		
202324L1	Tulare	88928.795	123455.93	FE	U	D	250	250		
202325J2	Tulare	84704.154	126052.33	FE	U	D	247.5	247.5		
202326C1	Tulare	86864.877	119369.96	FE	U	D	243.5	243.5		
202326R1	Tulare	82815.889	121746.67	FE	U	D	242	242		
202327D1	Tulare	86952.703	112823.6	FE	U	D	237	237		
202327R1	Tulare	82903.715	116738.05	FE	U	D	239	239		
202329J2	Tulare	84265.023	106545.07	FE	U	D	231.5	231.5		
202330R1	Tulare	82947.628	101448.58	FE	U	D	225	225		

Legend

A - A Clay
F - Forebay without A Clay
FE - Forebay within E Clay
U - Unconfined
CA - Confined
D - Deep mapping
S - Shallow mapping
B - Both deep and shallow mapping
X - Not used in groundwater mapping

KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX D – PROPOSED MONITORING WELL PLAN

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MEMORANDUM

To: Kings County Water District

From: Brian Ehlers, Shay Overton

Subject: **Proposed Nested Monitoring Wells for KCWD**

Date: November 3, 2010

Problem Statement

Kings County Water District has been monitoring groundwater conditions using an array of approximately 200 agricultural wells for many years. Time of use of irrigation wells and wells completed in multiple aquifers have tended to make analysis of groundwater levels and flow directions, overdraft and groundwater quality monitoring difficult. In addition, conjunctive use efforts in the Old River Channel have generated the need for high quality water level data in that area.

Recommendation

The Kings County Water District (KCWD or District) is proposing to install up to 10 nested monitoring wells on District owned lands in strategic locations within District boundaries. The nested monitoring wells will likely be triple completion wells installed in three tentatively identified aquifers, where applicable, beneath the District. Installation of the wells will proceed in two separate phases with the first three wells being constructed in Phase 1 and the remainder constituting Phase 2 or future phases. This memorandum outlines the potential benefits of dedicated monitoring wells, the tentative location of the wells and the anticipated depth intervals of the perforations for the individual casings in the nested monitoring wells.

Potential Benefits of Dedicated Nested Monitoring Wells

1. Depth Discrete Water levels – Static water levels could be obtained for identified aquifer zones. Additionally, static water levels from the monitoring wells could be used to aid the District in ongoing efforts to generate District wide groundwater contour maps. The monitoring wells could be used to supplement information from the indicator wells.

2. Ease of access – The wells will be located on District owned lands for ease of access.

3. Static Water Levels – Static Water Levels could be readily determined as the wells would not be used to generate water for consumptive use.

4. Increase Knowledge of Aquifer System – Accurate static water levels for identified aquifer zones would aid the District in understanding the regional aquifer system; helping to inform decisions on groundwater management.

5. Dedicated Transducers – Dedicated Transducers in the monitoring wells will give a continuous record of water level changes.

6. Strategic Location of Monitoring Wells – The nested monitoring wells can be strategically located to generate information on the amount and quality of groundwater flowing into and out of the District.

7. Permanent Locations for Groundwater Quality Monitoring and Assessment – The monitoring wells can be used to readily sample groundwater quality, thus establishing permanent groundwater water quality sampling locations. This would enable the District to assess changes to groundwater quality through time, as well as assessing differential groundwater quality for each identified aquifer zone.

8. Differentiate Horizontal Changes in Groundwater Quality – In casings identified as being perforated in the same aquifer zones the nested monitoring wells can be used to analyze regional horizontal changes in groundwater in the unconfined and confined aquifer.

9. Perched Groundwater Monitoring – In areas of perched groundwater shallow casings can be used to monitor groundwater quality and depth of the perched water.

10. Optional Deep Casing – In the southern part of the District, where water levels have historically been deepest, a casing completed to just above the saline water can be used to monitor possible vertical migration of saline, connate marine water.

11. Boring Logs and E logs – Boring Logs and E-logs from the monitoring wells could help the District better understand the northeast limits of the Corcoran clay and other regional hydrogeologic features.

Potential Locations and Casings Depths of Nested Monitoring Wells

The District overlies a complex fresh water aquifer system with both horizontally and vertically changing hydrogeologic conditions. The hydrogeologic setting changes from the northeast to the southwest from a largely unconfined aquifer to a more semi-confined to confined aquifer. The intent of Phase 1 monitoring wells will be to monitor groundwater conditions in areas that have been identified as critical (see Attachment). Future Phases or Phase 2 would include wells with locations largely driven by a need to

better understand horizontal and vertical changes in the hydrogeologic setting. The following is a general discussion on the theory behind the location of the monitoring wells and the tentative depth of the individual casings.

In areas underlain by the A clay and the Corcoran clay (southwestern portion of the District) three fresh water aquifers are recognized; a perched aquifer, an unconfined to semi-confined aquifer, and a confined aquifer. The perched aquifer is above the A clay from the shallow water table to depths of 30 to 60 feet bgs. The unconfined to semi-confined aquifer is below the A clay down to the top of the Corcoran clay to depths approaching 500 feet bgs in the southwest portions of the District. The confined aquifer is below the Corcoran clay to the base of fresh water ranging from about 240 feet bgs at the northern limit of the Corcoran clay to depths approaching 550 feet bgs in the southwest portion of the District to the base of fresh water which is about 3,400 feet bgs. In this area the individual casings for each well would be completed as follows. One casing would be perforated above the A clay in the perched aquifer from the top of the perched water table to about 30 to 60 feet bgs, one casing would be perforated between the A clay and the Corcoran clay solely in the unconfined to semi-confined aquifer, tentatively from depths ranging from about 250 feet to 500 feet. The deepest set casing would be perforated below the Corcoran clay in the confined aquifer and could be perforated as deep as 550 to 600 feet bgs depending on location and e-log verification of depth to the Corcoran clay.

In areas east of the A clay but within the eastern limit of the Corcoran clay, two clear aquifers are recognized; the unconfined aquifer above the Corcoran clay and the confined aquifer below. In these areas one deep casing would be perforated below the Corcoran clay in the confined aquifer in the depth range from about 250 to 400 feet bgs. The depth of the perforated interval will be determined after the final locations are known. An intermediate depth casing would be perforated in the unconfined aquifer immediately above the Corcoran clay (in the 180 to 250 feet bgs range), and another casing would be set at or just below the water table, with the depth largely dependent on the location of the water table.

There is some debate as to the northeastern extent of the Corcoran clay. The northeastern extent, traditionally used by the District is shown on the attached figure. In areas where there is no clear differentiation of the aquifers based on the presence of the clay layers, ie north of the northeastern extent of the Corcoran clay, the depth of the perforated interval would be determined by sight specific analysis of boring logs or E logs. As it is widely recognized that the unconfined aquifer becomes more confined with depth and increasingly confined in the southwestern part of the District, successive casings could be completed at depths enabling information to be obtained on the amount of confinement with depth in the unconfined aquifer. Alternatively, casing perforated intervals could be at depths to monitor aquifer zones of concern in a given vicinity.

Table 1 - Approximate Intervals for Perforated Depths of Casings and Depths of Aquifers

Aquifer	Depth to Top of Aquifer (ft) [1]	Depth to Bottom of Aquifer (ft) [1]	Casing Depth (ft)[2]
Perched	Perched Water Table	30 to 60	Perched Water Table to 60
Unconfined[3]	80	500	180 to 500
Confined	240	3,400	250 to 600

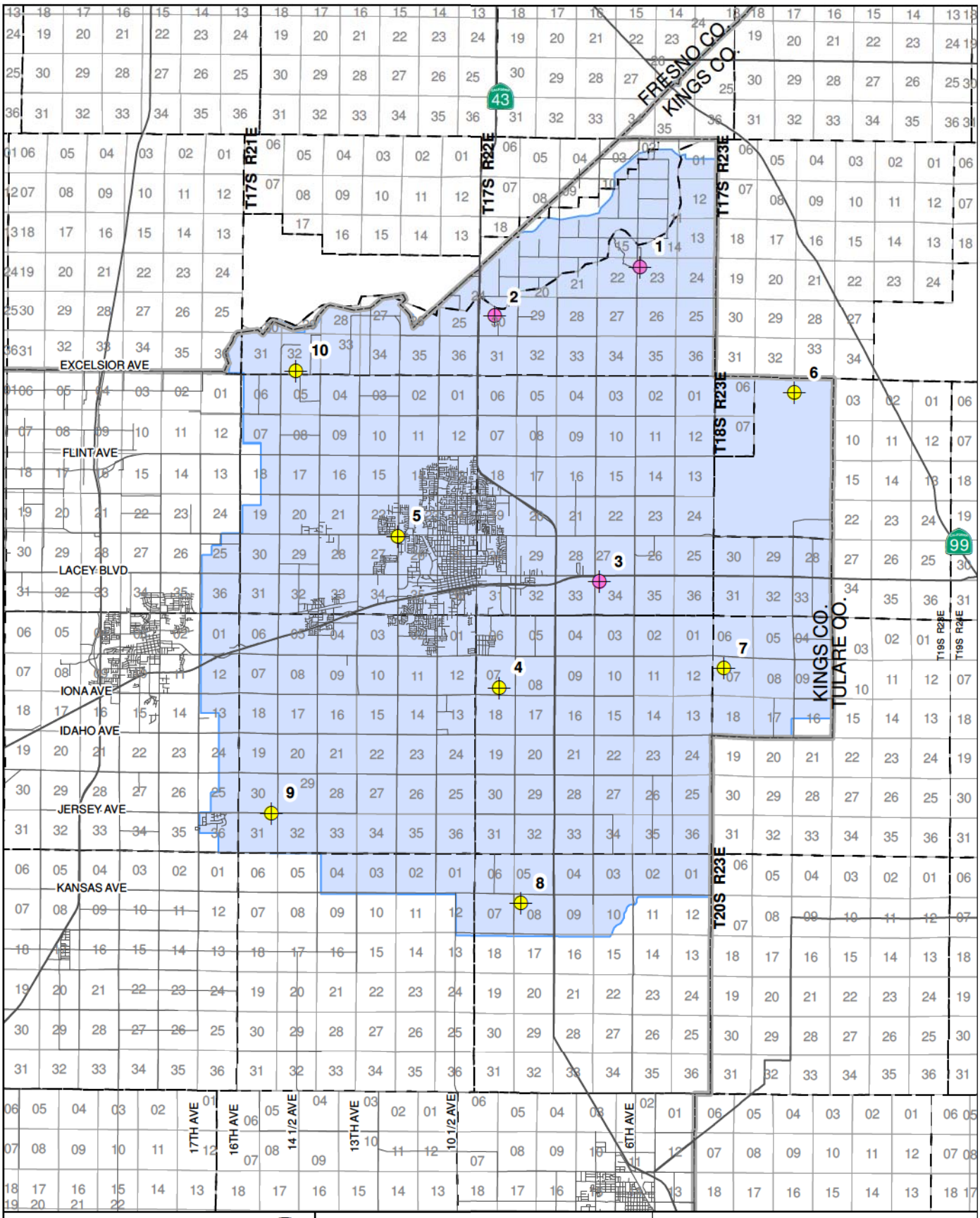
Notes
[1] – The depth of the A clay and Corcoran clay increase to the southwest across the District, thus the depths provided here cover the range of values.
[2] – The depth of casings in the unconfined and confined aquifers is highly variable depending on location, therefore the depth ranges provided here appear to overlap.
[3] – The depth to the top of the unconfined aquifer is dependent on the amount recharge and discharge. The depth to the top of casings perforated in this zone will be determined by field conditions

Phase 1

Phase 1 Wells are to be located in three areas previously identified as critical. Locations 1 and 2, on the attached map, were chosen to monitor groundwater conditions down gradient of conjunctive use efforts along the Old River Channel. Location 1 is in the northwest part of Section 23, T. 17S/R. 22E. Location 2 is in the center of Section 30, T. 17S/R. 22E. These locations are also ideally located to obtain information on the quality of water flowing into the northern parts of the District. Location 3, the southeast corner of Highway 198 and 7th Avenue at the new Garner recharge basin, was chosen to enable monitoring of groundwater conditions in the central portions of the District. In addition, near this location, Caltrans has been monitoring subsidence along Highway 198. The location of this monitoring well will enable analysis of groundwater conditions as they relate to subsidence. The shallow casing could be used to monitor the near surface groundwater changes when the new basin is actively recharging water.

Future Phases or Phase 2

Wells constructed in future phases would be located to obtain information on the groundwater conditions from a District wide perspective. The wells would be located to generate information on groundwater flowing into and out of the District, monitor areas of concern within the District, and the effects of municipal consumptive use of groundwater resources.



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KINGS COUNTY WATER DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX E – GROUNDWATER MONITORING PROTOCOLS

GROUNDWATER MONITORING PROTOCOLS

GENERAL SCOPE

The purpose of this document is to insure that the sampling and analytical methods are adequately documented and appropriate for the project scope and purpose by individuals responsible for implementing the monitoring program. Examples of all required forms are presented at the end of this section.

In general, measurements of the static water level will be taken from the top of each casing, and then the monitoring wells will be purged and sampled. A detailed description of these procedures follows.

EQUIPMENT USED DURING SAMPLING

Water level sounding equipment and field meter probes (pH, dissolved oxygen, conductivity, temperature, and turbidity) will be thoroughly rinsed with deionized/distilled water before and after each reading. All field meters will be calibrated according to manufacturer's guidelines and specifications before and after every day of field use.

The monitoring wells will be equipped with a dedicated sampling well pump or sampling activities will utilize disposable bailing equipment. All non-dedicated sampling equipment (in contact with sample) shall be thoroughly cleaned prior to each sampling event to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest in each sample. All sample containers and sampling equipment shall be sterilized and transported to the field under conditions to preserve its sterility. Personnel performing decontamination shall wear gloves, eye-protection, and such other safety equipment as needed. The analytical laboratory as part of their agreement shall provide all sample containers, container preparation services, preservatives, and field blanks.

EQUIPMENT DECONTAMINATION PROCEDURES

All equipment that comes into contact with potentially contaminated water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment. The following, to be carried out in sequence, is the recommended procedure.

- Non-phosphate detergent and tap water wash, using a brush if necessary;
- Tap water rinse; and

- Deionized/distilled water rinse.

WATER LEVEL MEASUREMENT PROCEDURES

Water levels will be measured in wells that have the least amount of known contamination first. Wells with known or suspected contamination will be measured last.

If wellheads are accessible, all wells will be sounded for depth to water from top of casing and total well depth prior to purging. An electronic sounder, accurate to the nearest +/- 0.01-ft, will be used to measure depth to water in each well. When using an electronic sounder, the probe is lowered down the casing to the top of the water column, the graduated markings on the probe wire or tape are used to measure the depth to water from the surveyed point on the rim of the well casing. Total well depth will be sounded from the surveyed top of casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if present, at the bottom of the well screen. Total well depths will be measured by lowering the weighted probe to the bottom of the well and recording the depth to the nearest 0.1-ft. Depth to water and total well depth will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section.

WELL PURGING

The wells will be sampled no sooner than 48 hours after well development. All wells will be purged prior to sampling. If the well casing volume is known, a minimum of three casing volumes of water will be purged using the dedicated well pump, if present, or a bailer, hand pump, or submersible pump depending on the diameter and configuration of the well. When a submersible pump is used for purging, clean flexible Teflon tubes will be used for groundwater extraction. Pumps will be placed 2 to 3 ft from the bottom of the well to permit reasonable draw down while preventing cascading conditions.

Water will be collected into a measured bucket to record the purge volume. Casing volumes will be calculated based on total well depth, standing water level, and casing diameter. One casing volume will be calculated as $\mathbf{V = \pi r^2 h\ 7.48}$ where **V** is the volume of one well casing of water in gallons ($1ft^3$ = 7.48 gallons); $\boldsymbol{\pi}$ = 3.14; **r** is the radius of the inner well casing (in ft); and **h** is the total height of the water column in the well (in ft).

It is most important to obtain a representative sample from the well. Stable water quality parameter field measurements (temperature, pH, and specific conductivity [EC]) indicate representative sampling is obtainable. Water quality is considered stable if for three consecutive readings:

- Temperature range is no more than +1/C;
- pH varies by no more than 0.2 pH units; and

- EC readings are within 10% of the average.

If the well casing volume is known, measurements will be taken before the start of purging, in the middle of purging, and at the end of purging each casing volume. If the well casing volume is NOT known, measurements will be taken every 2.5 minutes after flow starts. If water quality parameters are not stable after 5 casing volumes or 30 minutes, purging will cease, which will be noted in the field notes, and ground water samples will be taken. The depth to water, water quality field measurements, and purge volumes will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section.

If a well dewaters during purging and three casing volumes are not purged, that well will be allowed to recharge up to 80% of the static water column and dewatered once more. After water levels have recharged to 80% of the static water column, groundwater samples will be collected.

WATER LEVEL MEASUREMENT AND WELL PURGING RECORDS

During the collection of each sample, the following information will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section:

- Well identification;
- Sampler's name(s);
- Date and time of sample collection;
- Designation of sample as composite or grab, if applicable;
- Type of sampling equipment used;
- Field instrument readings and calibration;
- Field observations and details related to analysis or integrity of samples (e.g., conditions in nearby waterways, weather conditions, noticeable odors, colors, etc.);
- Preliminary sample descriptions (e.g., clear with strong ammonia-like odor);
- Time of arrival/entry on site and time of site departure; and
- Deviations from sampling plans.

PURGED WATER DISPOSAL

Purged and excess groundwater collected for sample container filling may be disposed on site or in the sampling area by dispersing onto the ground, or at the owner's direction.

ANALYTICAL METHODS AND REPORTING LIMITS

Requested analytes are provided in the following table. Reporting limits are laboratory specific based on the type of equipment each laboratory uses. Analytical methods and holding times are listed by analyte below.

Analyte	Standard Method	EPA Method	Holding Time
PH	4500H-B	150.1	24 hours
EC	2510B	120.1	28 days
Alkalinity	2320B	310.1	14 days
Ammonium	4500NH4	350.1	28 days
Bicarbonate	2320B	310.1	14 days
Carbonate	2320B	310.1	14 days
Chloride	4500Cl	300.0	28 days
Iron	3120B	200.7	6 months
Magnesium	3120B	200.7	6 months
Manganese	3120B	200.7	6 months
Nitrate as N	4500NO3	353.2; 300.0	48 hours
Nitrite as N	4500NO2	353.2; 300.0	48 hours
Phosphorus	4500P	365	28 days
Potassium	3120B	200.7	6 months
Sodium	3120B	200.7	6 months
Sulfate	4500SO4	300.0	28 days
TDS	2540C	160.1	7 days
TKN	4500-NH3	351	28 days

SAMPLE CONTAINERS AND PRESERVATIVES

Sample containers are generally available directly from the laboratory. All containers will be one-liter polyethylene, precleaned, and analyte specific. Groundwater samples for TKN and ammonia will be collected in containers containing H_2SO_4 as a preservative. The remaining samples need not be preserved. If a preservative is present, the bottle will be capped and lightly shaken to mix in the preservative. Samples from each location that require the same preservative may be placed in the same bottle if being analyzed by the same laboratory. Samples to be analyzed for dissolved metals must be filtered prior to preservation and analysis.

SAMPLING PROCEDURES

Water samples will be collected from each well and placed into laboratory prepared containers, sealed with tight fitting caps, labeled, and stored in a cool ice chest. Water used for field measurements of temperature, pH, and EC shall not be used as sample water. The following are the recommended sample collection procedures:

- Rinse the tubing with one liter of sample prior to sample collection;
- If no preservative is present, rinse sample bottles three times with a small amount of sample;
- Collect sample directly into the sample bottle;
- Allow sample containers to be open for the shortest time possible to prevent contamination;
- Do not touch the inside of bottles, lids, or tubes. Hold the bottle lid with the inside facing down to prevent contaminating the inside of the lid;
- Allow the sample water to flow into the bottle from above;
- Close bottle tightly,
- Samples will be chilled to 4 C^{o} immediately upon collection; and
- Transport samples to the lab as soon as possible.

At each sampling location, all bottles designated for a particular analysis will be filled sequentially before bottles designated for the next analysis are filled. If a duplicate sample is to be collected at this location, all bottles designated for a particular analysis will be filled sequentially before bottles for another analysis are filled.

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Every sample, including samples collected from a single location but going to separate laboratories, will be pre-assigned an identifiable, unique sample number. The following is an example sample label:

Sample #:	**Well ID:**
Analytes:	**Date:**
Collected by:	**Time:**

It will be possible to identify each unique sample by recording the following information on the Monitoring Well Purging and Sampling Record:

- Sample identification numbers and any explanatory codes;
- Sample date and time;
- Lot numbers of the sample containers;
- Chain-of-custody form numbers;
- Shipping arrangements (overnight air bill number); and
- Name(s) of recipient laboratory (ies).

CHAIN-OF-CUSTODY

A chain-of-custody (COC) record will be completed and accompany all sample shipments for each laboratory and each shipment. If multiple coolers are sent to a single laboratory on a single day, COCs will be completed and sent with the samples for each cooler. Generally, the laboratory will supply blank COCs. An example COC is included at the end of this section.

The COC will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. The sampling team leader or designee will sign the COC in the "relinquished by" box and note date, time, and air bill number.

SAMPLE HANDLING AND TRANSPORT

The following outlines the packaging procedures for sample delivery to a California Certified Environmental Laboratory Accreditation Program (ELAP) laboratory:

- Pack ice in zip-locked, double plastic bags. Seal the drain plug of the cooler with tape to prevent melting ice from leaking out;
- Line the bottom of the cooler with bubble wrap to prevent breakage during shipment;
- Check screw caps for tightness;
- Seal all container tops with tape;
- Secure sample labels onto the containers with clear tape;
- Wrap all glass sample containers in bubble wrap to prevent breakage;
- Seal all sample containers in heavy-duty plastic zip-lock bags with the sample numbers written on the outside of the bags with indelible ink;
- Place samples in a sturdy cooler(s) lined with a large plastic trash bag. Enclose the appropriate COC(s) in a zip-lock plastic bag affixed to the underside of the cooler lid;
- Fill empty space in the cooler with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment;
- Double seal ice in two ziplock plastic bags and place on top and around the samples;
- Secure each ice chest with strapping tape; and
- Secure address and shipping labels to cooler.

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Monitoring Well Purging and Sampling Record

Client: _____ Date: _____
Project Name: _____ County: _____
Project Address: _____
Project Manager: _____ Job No: _____ Phase(s): _____
Regulatory Contact: _____ Telephone: _____
Sample Containers: _____ Air Temp (F): _____
Preservatives: _____ Precipitation: _____
Instrumentation: _____ Wind (dir/speed): _____
Date Last Calibrated/By: _____ Sampler Signature: _____

Well Number						
Well Elevation (ft)						
Well Diameter (in)						
Slotted Interval (ft)						
DTW (ft)						
GW Elevation (ft)						
Sounding Depth (ft)						
Well Volumes (gal)						
Notes:						
Well Volume Purged (1st)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Well Volume Purged (2nd)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Well Volume Purged (3rd)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Sample Depth (ft)						
Sample Time						

Equipment used:

Remarks:

2" Well Volume = 0.163 x height of water column

4" Well Volume = 0.653 x height of water column